ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.
VOL. XLVI. No. 1.

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CHANGES IN THE DESIGN OF THE EARTH PORtion of the New Croton Dam and the embankments of the Jerome Park reservoir are under consideration, as will be seen by the following resolutions, adopted at an adjourned meeting of the Aqueduct Commissioners, held on June 21, 1901:

Whereas, In the prosecution of the work upon the New Croton Dam, on Croton River at Cornell site, in the town of Cortlandt, Westchester Co., N. Y., and of the Jerome Park Reservoir, near Kingsbridge, in the 24th Ward of the City of New York, certain conditions and circumstances have developed which suggest that a change or modification may be desirable in the plans for the construction of that portion of the dam designed to be constructed of earth with a masonry core-wall, and of the core-wall and embankment of the reservoir of somewhat similar construction; and

Whereas, It has been suggested by the chief engineer that, before any final determination is arrived at, advice should be sought from engineers of recognized ability and experience not connected with the present plans or the work of construction thereunder; therefore,

Resolved, That the President of the Aqueduct Commissioners be and hereby is authorized to employ Mr. J. J. R. Croes, Mr. Edwin F. Smith and Mr. Elnathan Sweet to examine the present plans for the construction of said dam, and the work of construction thereof so far as the same has proceeded, and also of the core-wall and embankment of the Jerome Park Reservoir of somewhat similar construction, and to report to the Aqueduct Commissioners what changes or modifications, if any, should be made in the plans for the construction of said dam and reservoir.

We are informed that the engineers named in the resolution have accepted the appointment and that the investigation is already under way. Mr. Wm. R. Hill, M. Am. Soc. C. E., is Chief Engineer of the Croton Aqueduct Commission.

SEWAGE PURIFICATION AT FITCHBURG, MASS., by means of intermittent filtration, has been recommended by Mr. Freeman C. Coffin, M. Am. Soc. C. E., of Boston, Mass. He proposes the immediate construction of 16 acres of beds, but estimates that 33 acres would be required for all the present flow and about 40 acres for the flow ten years hence. He also advises a small working plant to test one or more of the so-called bacterial methods of treatment. If the trial should prove satisfactory, such a plant might be constructed for the balance of the sewage, or that portion not treated on the 16-acre tract. In the light of present knowledge, both the first cost and the operating and capital charges for septic tanks and contact filter beds are estimated as about double the corresponding figures for slow-sand filtration. It is proposed that the various manufacturing wastes be treated with the city sewage, except that the wastes from paper mills, not including sewage proper, would be treated at the mills, by passage through strainer beds of coke or of cinders. It is thought that beds less than 2 ft. thick, operating at 1,000,000 gallons an acre per day, will give satisfactory results. The reason for separate treatment is the immense volume of paper mill wastes, estimated at 4,299,000 gallons a day, and the comparative freedom of the dirty water from decomposable organic matter. The report also advises the gradual substitution of the separate for the combined system of sewerage. Mr. David A. Hartwell is city engineer of Fitchburg, and has co-operated with Mr. Coffin in securing the information on which this report is based.

THE SANITARY PROTECTION of college students by means of the filling in and filing of blanks showing the condition of premises on which students board or lodge has recently been entered upon by the authorities of Princeton University, Princeton, N. J. The blank form, which is very full, is printed in the annual report of the New Jersey State Board of Health for 1899-1900.

ALL ORDINANCES REGULATING THE HEIGHT of buildings in Chicago, according to the Illinois Chapter of the American Institute of Architects, have proved ineffectual. On this account, and because eminent lawyers believe that restrictions on the height of "safely constructed buildings" is unconstitutional, the chapter has passed the following resolutions:

Resolved, That it is the sense of this chapter that all ordinances limiting the height of fireproof buildings in Chicago be repealed. It is further

Resolved, That on purely aesthetic grounds it is the general opinion of architects that city buildings should not exceed 100 feet in height, or thereabouts, and that some approach to uniformity in height, with a certain slight irregularity in roofs and skylines, would be desirable, but that it is now too late to seek such results, and we deem it useless to attempt to regulate the height of buildings by legislation, unless it is possible to make such legislation irrevocable and beyond the reach of any attempt to give special privileges to any persons.

The present limit to the height of buildings in Chicago is 130 ft. The resolutions were the result of an agitation for an increase of the limit to 175 ft., and a request to the chapter from one of the Chicago aldermen for an opinion on the subject.

THE MOST SERIOUS RAILWAY ACCIDENT of the week and the most serious that we have had occasion to record for a long period occurred near Peru, Ind., on the Wabash Ry. on June 26. A heavy rain had undermined an embankment and an express train was thrown from the track, resulting in the death of 16 persons and the serious injury of about 50 others. Nearly the entire train was wrecked. A sharp curve prevented the engineman from seeing the danger. The following statement in regard to the wreck has been given out by President Jos. Ramsey, of the Wabash Ry.:

The accident to Train No. 3 on the night of June 25 was not one which could have been guarded against. The accident did not occur on a bridge or trestle, but at a point where there has been a solid embankment for the last forty years. There is a small stream at this point, which has always been easily taken care of by a three foot stone culvert, and there has never been any high water at this point. Just before the accident two heavy clouds were noticed approaching each other some distance north of our line, but as this occurred late at night there is no definite information as to what really did occur.

It is supposed that when these two clouds came together there was a very heavy downpour of rain at the head of the small valley over which our embankment passed. The water rose some five or six feet above the top of our culvert, and passing down through the culvert caused a sort of a whirlpool action which cut into the bank on the north side and undermined the north half of the track, so that when the engine came on it it was thrown to the north and the cars went down the south bank. The culvert was not washed out and neither was the embankment completely destroyed.

THE STEAMER "LUSITANIA," belonging to the Orient Steam Navigation Co., was wrecked off Cape Ballard, Newfoundland, on June 26. The ship was bound for Quebec but lost her course in a dense fog and ran on to a reef. The 500 passengers, mostly immigrants, stampeded and fought for the boats with knives, but were finally overcome by the officers and crew and were all saved. The "Lusitania" was built at Liverpool by Laird Bros. in 1871, and was 379 ft. 9 inches long, and 41 ft. 3 ins. beam.

THE EXCURSION STEAMER "MOHAWK" ran onto a reef near Glen Island in Long Island Sound on June 29 and sank within a few minutes. Although the boat was crowded with about 900 passengers, many of whom leaped into the water, all were saved by two other steamers and the numerous pleasure boats which were in the near vicinity.

THE DITCHING AND SPREADING CAR on the Boston & Maine R. R., illustrated in our issue of June 28, 1900, is now working for the third season, and has proved itself so great a labor saver that the construction of another one has been considered. The car is at present being used to level back and push down the bank material dumped by a side plow from a construction train, which is at work widening an embankment for double-track. In this work it saves the expense of a gang of shovelers. Mr. Frank Barr, Assistant General Manager of the Boston & Maine R. R., informs us that on Sunday, May 12, this car did in four hours, work which it was estimated would have required 200 men all day to do by hand shoveling.

A SCHOOL FOR GERMAN RAILWAY EMPLOYES has been established at Munich, by the Bavarian State Railway. Two months' practical experience in railway work is required before taking the course; and the pupils are allowed partial pay while attending the school. Hereafter attendance for at least one term is obligatory upon all wishing to obtain positions. A telegraphic course is included, as well as courses in the higher executive and mechanical departments.

THE CAPE GOVERNMENT RAILWAYS, South Africa, had a financially successful year in 1900, the report of the General Manager showing that the military traffic incident to the war far exceeded the ordinary traffic in times of peace. At the same time, the military traffic proved disastrous to the ordinary traffic, thousands of tons of freight being left at the ports through inability to carry it. The 487 engines have an average cost of $14,960, and an average handling capacity of 200 tons on a grade of 2½%. During the year 10 Baldwin and 10 Schenectady engines were received from the United States, and 62 were under construction in Great Britain. The rolling stock included 618 passenger cars (all but 15 of which were mounted on trucks), and 7,049 freight cars (1,782 on trucks). The railways include 2,088 miles of line, with some branches under construction. Two of these are being built under contract by the Thames Iron Works, of London, England. Progress is unsatisfactory, however, and the report states that the experience serves as a warning to the government against entering into similar contracts in the future. A survey for a line east to Port Holloth is recommended, and surveys have been made for a 2-ft. gage line from Port Elizabeth to Avontuur. The work of reducing grades and curves is to be continued, and the introduction of heavier rails is recommended. Mr. C. B. Elliott, General Manager, closes his report by announcing his resignation (which took effect last May), after 42½ years of service.

A NEW CLASSIFICATION OF NAVAL VESSELS has been provided for in an order recently signed by President McKinley. There are four new ratings besides an unrated class, consisting of destroyers, torpedo boats, tugs, sailing ships and receiving ships. The regular ratings are as follows: First rate, men-of-war only, 8,000 tons and above; second rate, men-of-war of 4,000 tons and under 8,000 tons, and converted and auxiliary vessels of 6,000 tons and above, except colliers, refrigerating ships, distilling ships, tank steamers, repair ships, hospital ships, and other vessels for special purposes; third rate, men-of-war of 1,000 to 6,000 tons, and colliers, refrigerating ships, etc.; fourth rate, all other vessels.

AN EXPRESS STREET CAR SERVICE has been established on the lines of the Metropolitan Ry. Co. in New York city by the New York Electric Vehicle Transportation Co. The cars will start from the Battery at the lower end of Manhattan Island and run to Fordham in the Borough of Bronx, a distance of about 13 miles.

THE TALLEST CHIMNEY in the United States has recently been completed by the Alphons Custodis Co. of New York city, for the Oxford Copper Works at New Brighton, Staten Island. The chimney is 365 ft. in height above the ground and is exceeded by only a few in Europe.

WIRELESS TELEGRAPH COMMUNICATION is to be established by the Weather Bureau between San Francisco and the Farallone Islands, 30 miles from the Golden Gate. This region is subject to dense and sudden fogs, and it is expected that the service will be valuable to mariners, as well as to the Weather Bureau in the forecasting of storms.

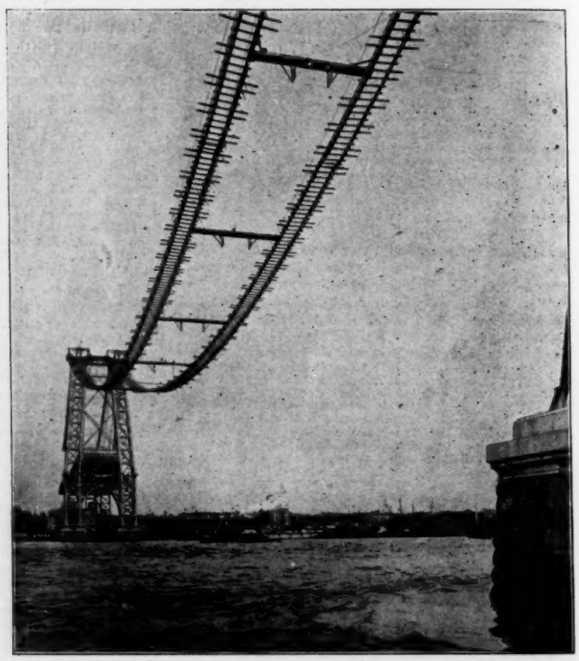
PROGRESS ON THE NEW EAST RIVER BRIDGE.

A short time ago (Eng. News, April 11) we noted the raising of a cable to form the first connection between the towers of the new East River bridge at New York city, or Bridge No. 2, as it will now have to be called to distinguish it from the structure which is to be erected at a point a little further south, and the cantilever bridge to be built at Blackwell's Island. Since that time additional cables have been placed and upon them have been built two foot-bridges, which will form working platforms for the construction of the main cables.

The accompanying recent photographs give a good idea of the foot-bridge construction in its successive stages, and of the present condition of the structure.

To the engineer, at least, these photographs tell on their face the story why the suspension type of structure is slow to erect compared with the truss type. On that frail and easily-swayed path the use of heavy power-driven machinery is out of the question, and the structure must be slowly assembled and adjusted by human muscle alone. In the truss type of structure, on the other hand, steam power places member after member in its position, and human muscle plays a very small part.

View Looking Toward Top of Brooklyn Tower.



Construction of the Temporary Foot Bridges for Use in Making Cables.

THE NEW EAST RIVER BRIDGE, NEW YORK CITY.

A CENTURY OF CIVIL ENGINEERING.*

By J. James R. Croes, President Am. Soc. C. E.

Ever since man became endowed with consciousness and the power of reasoning, he has been striving to solve the problems of the physical world around him.

Until about three hundred years ago, however, there does not seem to have been any systematic and well-directed effort to investigate the reasons why material changes occurred naturally, or how certain changes could be artificially produced with certainty.

Really, the civil engineer had been practicing his art and directing the forces of nature for the use and convenience of man, but without any conception of what those forces were, or how they acted. He did not know that the earth moved, and he had no idea why or at what rate a stone fell to the earth, or water ran down hill. He had no measure of heat or light, and used no power but that which the muscles of an animal produced. And yet he had built the Pyramids, the Parthenon and the Pantheon; had constructed aqueducts, canals and sewers; had regulated and maintained the rivers of China for thousands of years; and had just been recognized, on account of his labors in protecting the lowlands of Holland and the shores of Italian rivers from the encroachments of the water, as holding a distinct rank among the workers of the world.

Of the application of the forces of nature to aiding his labors, he seems to have been ignorant, except by the use of a flowing stream to turn a wheel. The earliest recorded application of this mode of producing power in England was in 1582, when Peter Morys, a Hollander, procured from the city of London a franchise for 500 years for supplying water to the city by pumping from the Thames, using a wheel driven by the ebb and flow of the tide under London Bridge.

With the beginning of the seventeenth century, the world entered on a new era of science, theoretical and applied. The casual observation by a little child of the curious optical effect obtained by looking through two pieces of glass led to the invention of the telescope and the microscope, which disclosed to man objects beyond the reach of his unassisted vision. The swinging of a hanging lamp suggested to a thoughtful man the idea of an unseen force, and Galileo, by experiment and reasoning discovered the law of terrestrial gravitation and first grasped the idea of force as a mechanical agent.

To Galileo, also, is due the invention of the thermometer, which enabled definite measurement to be made of the mysterious phenomenon of heat which his great contemporary philosopher in England, Lord Bacon, conceived to be "an expansive undulatory motion in the particles of a body whereby they tend with some rapidity toward the circumference, and also a little upward." But Bacon was 200 years in advance of the physicists, and the century was occupied almost exclusively in the elucidation of the laws of gravitation as exemplified in the action of fluids. For the study of liquids and their action demonstrated that they were, under certain conditions of temperature, transformed into invisible and elastic substances governed in general by the same laws, and also that there were all around other similar substances which could not be condensed into liquid inelastic form, but could be weighed by the barometer which Torricelli invented in 1643. And so the laws of gases came to be investigated and formulated by Mariotte, who, to aid him in his researches, invented the rain gage in 1677, and measured the liquids condensed from the atmosphere. The value of the data thus obtained, to the hydraulic engineer, was appreciated by the French engineers at once, and ever since 1681 records of the rainfall have been kept continuously at Paris, and the practice has gradually extended over the whole world. But it is worthy of note that 50 years after the invention of the rain gage, Belidor, in his magnificent treatise on hydraulic architecture (1728), the first compendium of engineering theory and practice, in treating of the sources of water supply for domestic use, did not mention the rain gage or the amount of rainfall, but dwelt on the divining rod as the recognized means of discovering subterranean streams of water.

The close of this century saw the final establishment of the law of gravitation by Newton's proof of its governing the whole material universe. And any review of the progress made during the century toward the understanding of the laws of nature would be incomplete without allusion to the two great steps taken in it toward the facilitating of mathematical computations, the invention of logarithms at the beginning of the century and of the calculus at its close.

Meanwhile the Civil Engineer had been making progress. In Italy, where the first application of science to construction had been made, the study of the laws of hydraulic science had been constantly pursued, and those laws applied to the regulation of the rivers; in France, ever ready to grasp new ideas and to pursue their application to practical results, the principles of hydraulics had been studied and applied to the construction of great canals, and to the supply of water to Paris, where, in 1671, water was pumped by a water wheel driven by the current of the Seine and distributed through cast-iron pipes. In England, Hugh Myddleton had supplied London with water and, in 1638, Nicholas Vermuyden had been called in from Holland to protect the lands along the River Ouse from overflow, a task so well accomplished that his work stood for a hundred years, and only failed then from lack of proper maintenance, the English having by that time apparently concluded that, as Dr. Franklin wrote in 1772, "rivers were unmanageable things," and, inspired by the success of the public waterways of France, turned their attention to the construction of canals and the improvements of harbors. Many important works of this class were built in England during the last half of the eighteenth century. The men by whom those works were constructed were not educated men or men experienced in scientific research. They certainly were men of great natural ability and good judgment, and capable of conceiving and executing great projects. One of the greatest of them, John Smeaton, who was the first Englishman to call himself a civil engineer, thus expressed his conception of the profession which he adorned:

> Civil engineers are a self-created set of men whose profession owes its origin not to power or influence, but to the best of all protection, the encouragement of a great and powerful nation, a nation become so from the industry and steadiness of its manufacturing workmen and their superior knowledge in practical chemistry, mechanics, natural philosophy and other useful accomplishments.

*From an address at the annual convention of the American Society of Civil Engineers, at Niagara Falls, N. Y., June 25, 1901.

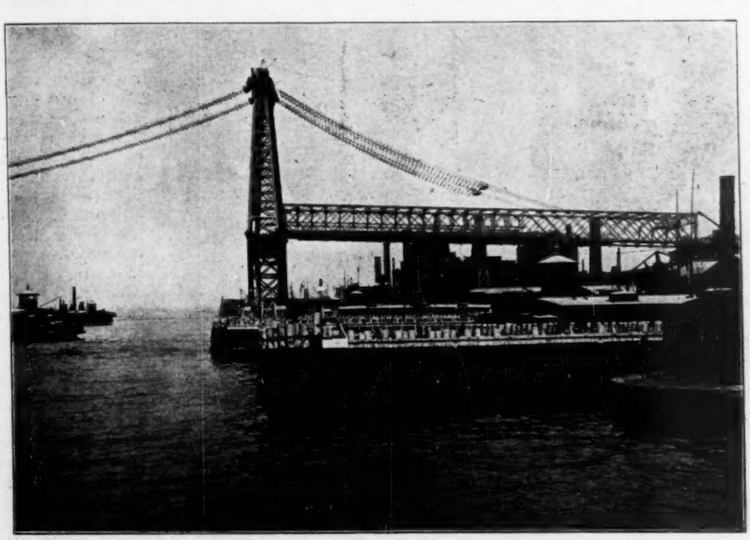
Smeaton was himself an investigator, but he is the only one of the civil engineers of Great Britain during the 18th century who strove to discover the laws which governed the operations of nature.

The most eminent civil engineer in England in the year 1800 was Thomas Telford, who was born in 1737. Beginning life as a mason, he developed an extraordinary faculty of generalization, combined with an intimate acquaintance with the details of workmanship in all the methods of construction known in those days. In the building of canals, highways, harbors, bridges and docks he displayed great grasp of the subject of the improvement of transportation facilities, as then existing, and great boldness of design and ingenuity in construction.

But it must be borne in mind that at that time the canal was considered the only possible mode of increasing facilities of transportation and reducing cost, no motive power except animal force was known, the metals were but little used in construction, and a framed structure adapted to bear heavy loads was unknown.

It is related of Telford that when on one occasion he was consulted by a young man as to the advisability of his engaging in civil engineering, he said to him: "I have made all the canals and all the roads and all the harbors. I don't see what there is that you can expect to do."

During the first quarter of the nineteenth century Telford stood at the head of the profession of civil engineering, and when, in 1820, the recently formed association of its practitioners for mutual advancement in science, which was termed The Institution of Civil Engineers, desired a prominent leader, he was chosen its President, and held that office until his death in 1834. He does not appear to have contributed to The Institution any papers or discussions on engineering subjects.



VIEW OF TOWER AND APPROACH.

Among the members of The Institution at that time was a man 30 years the junior of the President, who, like him, had risen from humble origin, and by his own exertions attained a high rank in the profession. Thomas Tredgold, born in 1788, began life as a carpenter, but soon devoted himself to the study of engineering science and its practice in the office of the Chief Engineer of the Ordnance Bureau. His "Treatise on Carpentry," in 1820, was the first published attempt to determine scientifically and practically the data of resistance of beams to transverse flexure. During the next seven years he contributed to the Transactions of the Institution of Civil Engineers papers showing the mode of application of science to engineering problems, and he also published treatises on Warming and Ventilation, on Steam Navigation, on Railroads and Carriages, and on the Steam Engine. It was to him that the Institution turned when it wished to apply for a Royal Charter, in 1828, and requested him to prepare a definition of Civil Engineering.

As we look back upon the history of science, theoretical and applied, during the first quarter of the nineteenth century, we can see how a new definition of the profession of Civil Engineering was needed at that date.

At the very beginning of the century there had occurred a marvelous revolution in the conception of the nature and operation of the laws governing matter and its motion. Lavoisier had revolutionized chemical science and Dalton had propounded a theory of atomic constitution of matter which has been sustained by observation and reason.

Just with the incoming of the century, too, came Rumford's demonstration of the fact that heat was not a material substance, but only a mode of motion. Almost simultaneously was propounded the theory of Thomas Young, that light, too, was not material, but was simply due to vibratory motion in an all-pervading medium to which he gave the name of the luminiferous ether. It was in 1800, too, that Volta demonstrated that an electric current could be artificially produced. Fitch and Fulton, with the aim of reducing the cost of water transportation, succeeded in applying the steam engine to the propulsion of boats, and Trevithick made successful application of steam propulsion to vehicles on land. Murdock had proved that illuminating gas could be produced and distributed to consumers. The civil engineers of the day had seized on all these inventions and discoveries, and in both Europe and America were designing and constructing works to render them useful to the greatest number of people.

Reviewing then what had been accomplished during the first quarter of the century, Tredgold could not but perceive that civil engineering was something broader and more comprehensive than the mere construction of harbors, breakwaters and canals, and he presented on January 4th, 1828, in response to the request of the Institution, this ever memorable definition of Civil Engineering:

> Civil Engineering is the art of directing the great sources of power in Nature for the use and convenience of man; being that practical application of the most important principles of natural philosophy which has, in a considerable degree, realized the anticipations of Bacon, and changed the aspect and state of affairs in the whole world.

After a brief sketch of the objects of Civil Engineering, he added:

> The real extent to which it may be applied is limited only by the progress of science; its scope and utility will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical art, since its bounds are unlimited, and equally so must be the resources of its professors.

A more concise and comprehensive definition of a great truth can hardly be conceived. From a physical and intellectual standpoint, a nobler aim for the exercise of the mental powers cannot be imagined than the direction of the great sources of power in Nature for the use and convenience of man. Philosophy, Physics and Civil Engineering must work hand in hand. The philosopher must imagine, the physicist prove by experiment and mathematical computation, and the engineer apply to practice the laws of matter.

With the advance of science, the scope of civil engineering widened and advanced. The study of the action of forces induced analytical investigation of the means by which forces could be resisted and the best results obtained from proper distribution and arrangement of materials of different kinds. Steamships and locomotive engines were constructed by which the products of the earth and the manufactures of man, by machines and methods not before conceived, could be transported across the seas and overland by artificial highways and across bridges of previously unimagined span; and light and heat and electricity and water could be delivered in the apartment of every person to be used at will.

It was in the carrying out of the delivery of pure and wholesome water and the removal of its unused surplus that the civil engineer first was called on to deal with organic life. That minute organisms affected the comfort and the health of man had been recognized for hundreds of years. In the middle of the seventeenth century Leeuwenhoek, a Dutch maker of microscopes, discovered and described bacteria, and Nicholas Andry, a pathologist, ascribed to them the causation of disease. But later scientists discarded the idea, and it was not until 1831 that any real advances were made in the study of these micro-organisms, and it is only within the last twelve years that it has become thoroughly recognized that the regulation of the growth of living organisms in air and water and sewage is necessary and practicable, and comes within the domain of civil engineering.

In considering the means of directing the great sources of power, the psychological element must not be forgotten. A mere intellectual application of the laws discovered by physical research is not enough to make a civil engineer. Breadth of view, the faculty of analyzing what has been done so as to discover how and why some enterprises have been successful and others have not, and the ability to forecast the future, are essential. These qualities are largely natural, but may be cultivated to a great extent by study and experience. That there has been a wonderful advance in this direction during the nineteenth century is shown by the great number of civil engineers who hold positions of prominence in the management and control of large enterprises which require the exercise of faculties that cannot be acquired in any other way than by experience in the designing, construction and manangement of engineering works.

A prominent factor in causing this advance in engineering science which has occurred simultaneously on the continent of Europe, in Great Britain and in America, has been the collaboration of scientists. By the middle of the century it had become apparent that Civil Engineering was not the prosecution of a specialty, but was the coordination and direction of the work of all specialties in science and its application. And so in 1852, James Laurie and his associates, following the example of their English brethren, founded The American Society of Civil Engineers, the first and only national organization devoted to "the professional improvement of its members, the encouragement of social intercourse among men of practical science, the advancement of engineering in its several branches and the establishment of a central point of reference and union for its members." To the privileges of its membership may be admitted not only every "professional engineer," but also "any person who by scientific acquirements or practical experience, has attained a position in his special pursuit qualifying him to co-operate with engineers in the advancement of professional knowledge and practice." This meeting of that society, which now has 2,500 names upon its roll of membership, and owns a commodious society house with a reference library of some 40,000 titles, is sufficient proof of the wisdom of its founders.

The most thorough exemplar of the condition of civil engineering at the beginning of the twentieth century is the modern office building in a great city. A hundred years ago, the man of enterprise who resided 50 miles from a large city and wished to consult an engineer regarding a project for a new canal, arose before daylight, struck a spark from his flint and steel, which falling on a scrap of tinder was blown by him into flame and from that a tallow dip was lighted. In the same primitive manner the wood fire was kindled on the kitchen hearth and his breakfast was cooked in a pot and kettle suspended from the iron crane in the fireplace. Entering the cumbrous stage coach, hung on leather springs, which passed his door, he was driven over muddy roads, crossing the narrow streams on wooden trestle bridges and the navigable rivers on a ferryboat, the paddle wheels of which were turned by a mule on a treadmill. At last he was landed in the city where he walked through dirty streets paved with cobble stones until he reached his destination, a plain three-story brick building founded on sand, with a damp cellar and a cesspool in the back yard. Entering a dark hall he climbed a wooden staircase and was ushered into a neat room, rag-carpeted, warmed by a wood fire on the open hearth and lighted by a sperm oil lamp with one wick, for it was dark by this time. No wonder that before proceeding to business he was glad to take a good stiff noggin of New England rum.

To-day, his grandson, living at the old homestead, while comfortably eating his breakfast, which has been cooked over a gas range, reads in his morning paper that the high dam of the irrigation reservoir in Arizona, in which he is interested, sprang a leak the day before, and he telegraphs to his engineer in the city that he will meet him at his office at noon. Then, striking a match, he lights the lamp of his automobile which is fed by petroleum brought 200 miles underground in pipes from the wells, and rolls over macadamized roads to the railroad station. Here he boards a luxuriously appointed train, by which he is carried above all highways, through tunnels, under rivers, or across them on long-span steel bridges, and in an hour is deposited in the heart of the city, where he has his choice of proceeding to his destination through clean and asphalt-paved streets in electric surface cars at 9 miles an hour, elevated steam cars at 12 miles an hour, or through well-lighted and ventilated tunnels at 15 miles an hour. Reaching the spot his grandfather had visited, he finds there a huge and highly decorated building, twenty or more stories high. It is founded on the primeval rock, far below the surface of the natural ground, the superajacent strata of compressible material having been penetrated by caissons of sheet metal sunk by the use of air, compressed by powerful pumps driven by steam or electricity generated at a power station half a mile or more away, and these caissons filled with a manufactured rock such as the or-

dinary processes of nature would require millions of years to produce. Upon these foundations there is erected a cage of steel, the composition of which has been specified, and the form and mode of construction of which have been so computed that the force of the elements cannot overthrow the structure or even cause it to sway perceptibly. Towering above the courts of Law, the temples of Religion and the palaces of the Arts, the meshes of this mighty cage are filled with products of the earth, the mine and the forest, transformed so as to be strong and light and incombustible, and all interwoven with pipes and wires, each in its proper place and noted on the plans. In one set of these pipes there is pure water, which has been collected from a mountain area of igneous geological formation, depopulated and free from swamps, on which a record of the daily rainfall is kept, and in which impounding reservoirs have been constructed by masonry dams across its valleys. From these reservoirs, the water, after filtration through clean sand, is conveyed 30 or 40 miles through steel or masonry conduits to covered reservoirs, whence it is drawn as needed through cast-iron pipes to the building where it is to be used, and there distributed to all parts of it, chilled nearly to the freezing point through one system of pipes or heated nearly to the boiling point, through another system. Another set of pipes carries steam which, passing through radiators, keeps the temperature of the air throughout the building at the proper standard for comfort. Sanitary conveniences are provided everywhere, and all wastes are consumed within the building by the surplus heat generated, leaving only ashes to be removed. Wires convey electric currents to all points, so that the occupant of a room, sitting at his desk, can by the touch of a button ventilate his apartment, illuminate it, call a messenger, be kept informed of every fluctuation in the markets, converse with anybody who is not "busy" within 40 miles of where he sits, and if entirely "up to date" can require his autograph and portrait to be reproduced before his eyes for identification. He dictates his correspondence and his memoranda, and "takes his pen in hand" only to sign his name. He need not leave his seat except to consult the photograph hanging on his wall, which shows to him the latest condition of the mine, the railroad, the arid lands irrigated, the swamps reclaimed, the bridge in progress, the steamship, the water-works, the tunnel or the railroad, the dam, the filter or the sewage works, the town, the machine, the power plant or the manufacturing establishment in which he is most interested.

Entering the brilliantly lighted hallway of this building, the air of which is kept in circulation by the plunging up and down of half a dozen elevators, the visitor is lifted at a speed of 500 ft. a minute, past floor after floor, crowded with the offices of financiers, managers and promoters of traffic and of trade, lawyers, chemists, contractors, manufacturers, to the headquarters of the controlling genius of the whole organism, the civil engineer. For he it is to whom all the members of this microcosm must apply for aid and advice in the successful operation of their respective occupations. It is not his to mechanically transform elements into matter, or matter into other forms, or to show how energy may be produced, but to direct the application of energy to the various forms of matter, original or produced, in such way as to bring about the most satisfactory results in the most speedy and economical manner.

He has grown with the growth of the nineteenth century, and is, so far as the relations between man and matter are concerned, its most striking product. And so, while the definition given in the "American Edition of The Encyclopaedia," which appeared at the beginning of the century, that: "Civil Engineers are a denomination which comprises an order or profession of persons highly respectable for their talents and scientific attainments and eminently useful under this appellation," is still true, it is hardly probable that the compiler of the Twentieth Century Encyclopaedia will be content to let it stand without further explanation.

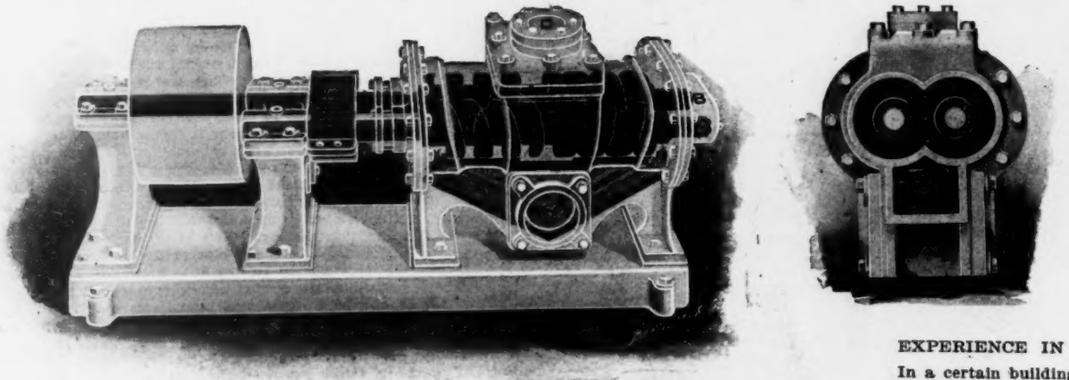
But the end is not yet: there are still many problems of Nature unsolved. The experience of every day shows that there are sources of power not yet fully developed, and we cannot but say with the great poet:

"I doubt not through the ages one increasing purpose runs,
And the thoughts of men are widened with the process of the suns."

A STUDY IN ELECTRO-HYDRAULICS.

By Frank A. Pattison,* M. Am. Inst. Elec. E.

One of the first applications of the electric motor was the operation of a pump for the purpose of conveying water. For a long time, on account of the high-speed motors, it seemed to be more practical to operate a power pump by means of a belt, but for the past few years several attempts have been made to do away with the belt and make a direct-connected motor and pump. This has been carried out by several different methods, with varying degrees of success. It required too much mechanism to pass from the rotary motion of the armature to the travel of an ordinary piston. It was therefore necessary to do away with the well-known form of piston and devise a new one. Fig. 1 shows very clearly the principle upon which the pump referred to is made. The screws act as pistons, propelling the water, and they are mounted in pairs on parallel shafts, arranged in such a way that the thread of one screw projects to the bottom of the space between the threads of the opposite screws. The sides of the screw threads are undercut in a peculiar manner, and the faces are left flat, so that the width of the face and the base of the thread is one-half the pitch. The cylinders of the pump fit the perimeter of the threads snugly, as may be seen in Fig. 2. There is space enough left between the screws and the cylinder and between the faces of the intermesning threads to allow a close running fit without actual contact. There is absolutely no end thrust in the pump, because the water is delivered from the middle of the cylinder, and the pressure of the column of water is exactly the same in one direction as it is in the opposite, therefore all pressures counterbalance each other. Such a pump can be very readily connected direct to the shaft of an electric motor by placing the armature where the pulley is shown in the figure. Up to the present this pump direct-connected to an efficient electric motor seems to represent the most economical method of handling water. Such a combination cannot successfully compete with a high-duty pumping engine where it is desired to move a large amount of water, and a full load for the pump is assured.



FIGS. 1 AND 2. SIDE AND END VIEWS OF QUIMBY SCREW PUMP.

*Of the firm of Pattison Bros., Consulting Electrical Engineers, 141 Broadway, New York.

TABLE I.—Results of Tests of Direct-Connected Electric Pump.

Time.	Volts, machine.	Amperes in—Machine.	Amperes in—Field.	Amperes in—Magnet.	Head and lift frm water level.	Gallons per minute.	Weight of discharged water.	Ft.-lbs.	K-W. Input.	K-W. Output.	Efficiency, %.	Speed, revs. pr min.
3.44	494	113	1.07	0.222	239	793	6,620	1,582,000	55.85	35.8	64.1	648
3.47	495	114	1.08	.222	239	793	6,620	1,582,000	56.45	35.8	64.1	648
4.01	500	115	1.08	.222	243.5	798	6,660	1,620,000	57.5	36.65	63.7	650
4.22	496	118	1.07	.222	239	804	6,710	1,603,000	58.55	36.25	62.0	660
....	476	250	....	.212	285	...	.....	.....	119.0	.....	....	560
4.49	516	118	1.09	.232	250.5	818	6,825	1,710,000	60.9	38.66	63.5	670
5.07	510	118	1.08	.232	250.5	818	6,825	1,710,000	60.2	38.65	64.2	665
5.28	517	122	1.09	.232	255	825	6,890	1,758,000	63.1	39.75	63.0	675

TABLE II.—Test of a 75-HP. Electric Motor.

Volts, machine	Amperes, machine.	Core loss and friction.	C²R armature and brushes.	C²R series field.	C²R shunt field rheostat.	C²R magnet.	Total loss.	K-W. input.	K-W. output.	Efficiency, %
494	113	2,385	1,460	850	529	109	5,333	55.85	50.52	90.5
495	114	2,385	1,485	865	535	110	5,380	56.45	51.07	90.4
500	115	2,385	1,515	880	540	111	5,431	57.5	52.07	90.5
496	118	2,385	1,595	928	531	110	5,549	58.55	53.0	90.5
476	250	2,385	.....	...	...	.....	.....	.....	.....	....
516	118	2,385	1,595	928	563	120	5,591	60.9	55.31	90.8
510	118	2,385	1,595	928	551	118	5,577	60.2	54.64	90.8
517	122	2,385	1,700	990	564	120	5,750	63.1	57.34	90.8

But from tests we have made it seems to be more economical than any single or duplex steam pump, or in fact than any steam pumping engine that is not provided with automatic cut-off.

One of the foremost questions to-day in fire insurance circles is the proper precautions to adopt to be enabled to fight a fire from the upper floors or roof of one of our modern skyscrapers. A very practical method has been arrived at by the adaptation of the above-mentioned combined motor and pump. A most important question, in fact the vital one, for the owner of a skyscraper, is what is the best and most economical method of transporting the tenants. Strange as it may seem, the operating of a hydraulic elevator system and the extinguishing of a fire involve the same operation, viz., the supplying of a sudden demand for water and a method of rendering this supply practically inexhaustible. This seems to us to give room for a rather interesting study in electro-hydraulics, and we are pleased to be able to give the results of such an examination and test. The general practice in the solution of both of these problems is to use pumps taking a large amount of steam. And this, too, where there is a steam engine on the premises requiring one-quarter the steam.

EXPERIENCE IN ELEVATOR SERVICE.

In a certain building operation upon which the author was retained for the solution of some of the engineering problems, it became necessary to operate a system of five hydraulic elevators in a ten-story office building without the utilization of steam. There being a 500-volt power line in the vicinity, it was very natural to turn to this source, and we accordingly installed two Quimby screw pumps, direct-connected to Eickmeyer electric motors. The governing was so arranged that one of these units does all the work up to its utmost capacity, and then the second one cuts in to share the load.

The cost of the operation of such a system can be seen from the following table, giving the watt-hours of energy consumed:

Dec. 31 to Jan. 31..2,166,100	Feb. 28 to Mar. 31..3,060,100
Jan. 31 to Feb. 28..2,563,400	Apr. 30 to May 31..3,819,800

The cost of the current used can be arrived at very readily from this table by multiplying by the rate at which electric current is supplied at the various locations considered. The increase in the amount of energy used in the later months is due to a change in the method of running the elevators.

The cost of operating this combination, when compared with the cost of operating the ordinary steam pump outfit customarily installed in large buildings, shows a manifest economy. The steam pump manufacturers are willing to guarantee an

TABLE III.—Net Results of Test of Electric Pumping Plant.

Machine Volts.	Machine Amperes.	Head and lift from water level.	Weight of Gallons discharged per min.	Weight of water.	Ft.-lbs.	K-W. Input.	K-W. Output.	Plant efficiency.	Size of nozzle.	Head pressure.
514	131.5	285.5	750	6,260	1,788,000	67.55	40.4	59.9	1⅝ ins.	123.7 lbs.
512	122.8	262.5	776	6,480	1,700,000	62.90	38.45	61.2	"	113.9 "
514	116.2	239.0	814	6,790	1,623,000	59.65	36.75	61.6	2 "	103.7 "
514	96.5	193.0	889	7,420	1,431,000	49.55	32.40	65.4	2½ "	83.8 "
516	75.6	151.5	914	7,630	1,155,000	39.0	26.15	67.0	"	65.8 "

efficiency of 75% between steam and water, but they start with a pump using a large quantity of steam, so that the efficiency so far as coal is concerned is very low. The efficiency of the above-described electrical outfit is shown by the following test:

No. test.	Average speed, revs. per min.	Water—Average press., gross.	Water—Pumped.	HP. hours—Theoretical required.	HP. hours—Expend'd.	Efficiency of combination wire to water.
1.	633⅛	84 lbs.	19,343.75 lbs.	1.857	3.166	58.65%
5.	612	101 "	18,734.375 "	2.1691	3.612	60.05%
6.	604¼	122½ "	16,095.75 "	2.266	4.227	53.60%
7.	605⅛	130 "	14,468.75 "	2.1633	4.5308	47.74%

The above tests were arrived at by the following method: Fill the suction tank in the basement, pump from it and throttle the discharge to get desired pressure on gage. Measure the amount of water pumped by the height in the suction tank. Corrections for height and leakage were made, and each test continued for three minutes, electrical readings being taken every quarter minute.

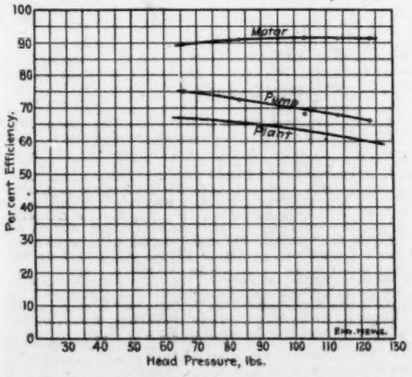


Fig. 5. Diagram Showing Efficiency of Electric Pumping Plant.

The first cost of a steam pumping outfit for this service would be more than the cost of the electro-hydraulic outfit, according to figures given us by one of the prominent elevator companies.

At first glance the difference in these tests show a not very great difference in efficiency between the two systems, but when it is taken into consideration that the amount of steam used from the boiler for the electro-hydraulic outfit is very much less than that for the steam-hydraulic outfit, we see that a decided advance has been made in efficiency, and this to the owner is a great advantage, as the question of all importance to him is not what any individual unit of his entire mechanical plant costs, but the total cost of running his entire outfit, reduced to pounds of coal at the boiler. Therefore, if this item, the operating of elevators, can be reduced, his total cost of operation is reduced in proportion.

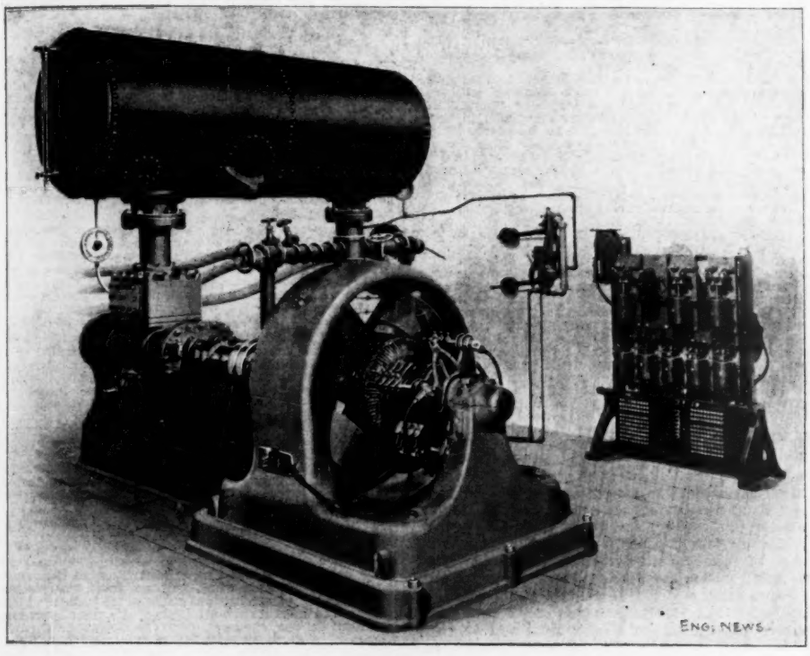


FIG. 3. AN ELECTRIC PUMPING PLANT FOR FIRE PROTECTION.

The plant above described has been in continued operation since October, 1899, and is giving good satisfaction. It would be difficult to imagine more disadvantageous surroundings than it has had. Every one knows the constant dirt, dust and grit that gathers on machinery during a building operation. In spite of having this in its worst form to contend with, this equipment has never had to be shut down, and now after 18 months' hard use and abuse, all that is necessary is the renewal of the screws, which have been ground by the dirt.

Now that we have seen that this equipment fulfils its purpose in operating elevators, perhaps it is better to turn our attention to the other problem, viz., a practical and efficient method of fighting a fire in the upper floors or roof of one of our modern skyscrapers. Fig. 3 shows the outfit which it is proposed to place in a cellar of any building desiring protection. This shows a General Electric motor direct-connected to a Quimby pump, which is piped to a pressure tank. From this pressure tank a small pipe is run to a Ford regulator, which in its turn operates an automatic starting device in connection with the motor, which is shown at the right hand of the figure. Under the left-hand side of the tank will be seen a small dial marked from 1 to 24. By turning the pointer on this dial a valve is operated which regulates the leakage of water from the tank, so that the motor will be thrown into operation as many times as is desired, according to the point on the dial to which the valve is turned. Thus it is certain that the apparatus will be in perfect working order whenever called upon. The current supply can be obtained from the street service or from the isolated plant, or both, at will.

The ability of this outfit to throw water is illustrated in Fig. 4, where three hose lines have been carried out from the tank to a convenient point. This is taken from a photograph taken during an actual test, and the height of the streams can be seen from the height of the familiar objects in the picture.

The outfit shown in Fig. 4 has been thoroughly tested. The author went very carefully over the entire apparatus and tests, and is glad to be able to give herewith figures of the same from the records taken under the direction of Messrs. Pierce & French. The apparatus proved itself to be perfectly reliable for quick response and continuous operation. Its durability is shown above in the elevator equipment. The efficiency of the pump is evident from the figures in Table I.

The second step was the test of the motor, which was a four-pole 75-HP. machine-type, running at 675 revolutions and wound for 500 volts. It was provided with sixteen brushes, each 1¼ ins. by ⅝-in. The results of the test are given in Table II.

The final test is really the most important, viz., the efficiency of the plant. This means the actual efficiency from wire to water allowing for all losses. We give the tabulated results in Table III. and they are plotted to scale in Fig. 5.

The Ford Regulator is shown in Fig. 3. The pipe from the pressure tank is connected at the top of the top cylinder. The water supply pipe is connected with the lower or supply port of the regulator. It will be seen then that if the pressure on the tank, which it is desired to maintain, is counterbalanced by the weight on the arm, the lever on the bottom is connected with the switch in connection with the electrical outfit. Any variation in the pressure of the tank will vary the position of the lever, which admits the water and operates the arm connected with the electric switch; so that the pressure on the tank by this means can be kept at any desired point. The mere act of turning on the valve connected to any hose joined to this system operates the regulator which actuates the magnetic motor starter, which starts the motor so that the supply of water is immediate, continuous, and practically inexhaustible.

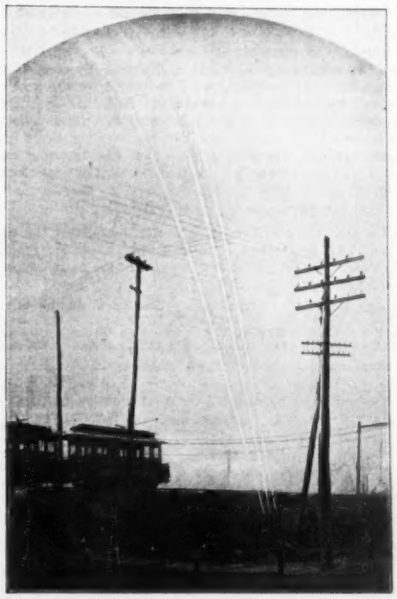


Fig. 4. Fire Streams in Test of Electric Pumping Plant.

This equipment is identical with one for the

operation of electro-hydraulic elevators, and it would be a very easy matter to have connections made so that the fire extinguishing outfit in an emergency could be used for the elevator, or vice versa; and by this means both systems would have an extra unit in case of accident without the extra expense.

The facts and inferences culled from the study of these questions and tests have been very interesting to the author, and he hopes they may prove of value to the readers of this article, and p s i bly bring about an exchange of views on a subject concerning which the information at present is very meager.

ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION.

(Concluded from p. 476.)

SECOND SESSION.

The first business of the session was the reading and discussion of the report on Triple Valve Tests. The standing committee in charge of these tests reported that one triple valve, known as the Hibbard valve, had been submitted for test, and also gave in full detail the results of the test. Summarized briefly, the valve failed to meet four of the standard requirements of the Association, but in only one instance was this failure a serious one. This most serious failure was the failure of the valve to meet the emergency requirement. Full emergency should have been shown with a 14-64-in. opening, but in the test it was not shown until full opening was given. There was no discussion of the report.

The next report was that of the standing committee on Laboratory Tests of Brake Shoes.

LABORATORY TESTS OF BRAKE SHOES.

The committee reported that twelve brake shoes had been submitted for testing during the year, and gave in full detail the results of each test. The accompanying tables (Tables I. and II.) give a condensed summary of these results. The committee also proposed the following specifications for brake shoes, having the standard M. C. B. dimensions:

Shoes when tested on the Master Car Builders' testing machine in effecting stops from an initial speed of 40 miles an hour shall develop upon a cast-iron chilled wheel a mean coefficient of friction of not less than:
22% when the brake-shoe pressure is 2,808 lbs.
20% when the brake-shoe pressure is 4,152 lbs.
16% when the brake-shoe pressure is 6,840 lbs.
For steel-tired wheels the mean coefficient of friction shall not be less than 16% at a pressure of 2,808 lbs.; 14% for 4,152 lbs.; and 12% for 6,840 lbs.

The rise in the value of the coefficient of friction at the end of the stop shall be within such limits that the value of the coefficient of friction for a point 15 ft. from the end of the stop will not exceed the mean coefficient of friction by more than 7%.

It will be readily observed from the tables which of the shoes tested met the requirements of the specifications.

DISCUSSION.—In introducing the report, Mr. S. P. Bush stated that two of the shoes tested, namely the Lappin and the Cardwell, were furnished by the makers and not by the railway companies. He also stated that the Lappin shoe which was submitted was not the regular Lappin shoe put on the market. After a brief discussion it was voted to submit the specifications suggested by the committee to the Association for letter ballot as a standard.

TESTS OF M. C. B. COUPLERS.

This committee is a standing committee of the Association, and its report was quite long and of a rather special character. The following are excerpts of the parts of most general interest:

As during the previous year, the work of the committee has been largely that of perfecting, by actual service, the details of the work submitted at the two previous meetings of the Association. As a result of the experience had during the past year, changes of considerable importance have been found necessary in the specifications of M. C. B. couplers, and minor changes have been thought advisable in the drop-testing machine and the coupler contour gage. No changes have been found necessary in either the worn coupler gage or the twist gage, except to make the latter adaptable to the new design of coupler with increased shank.

The specifications in their present form have not proved as commercially practicable as is considered advisable, due partially to their lack of definiteness and to their severity, and also because there are certain portions of the specifications which, in the judgment of your committee, are unnecessary. The modifications to which the committee particularly calls attention are: First, the requirements of the specifications have been made uniform for couplers, whether of cast steel or malleable iron; second, the abandonment of the separate knuckle test. An extended experience with the M. C. B. testing machine has forcibly impressed on the committee the advantages of good, well-annealed cast steel as a material from which to make the body of the coupler; so much so that in its judgment it is inadvisable to longer retain in the specifications any preferential test for any other material. The separate knuckle test, in connection with the test of couplers is an unnecessary expense.

Since the last meeting of the Association the committee has experimented very largely with couplers with increased shank and now presents a design of shank 5 × 7 ins. back of the head, with the larger dimension in horizontal plane, as its recommendation as standard of the Association. This recommendation is made after serious consideration of the changes that will be necessitated in the various parts affected, but a change must be made to get increased strength, and the proposed change gives us this increased strength with the least additional material, and less seriously affects the related parts than would the change to a 6 × 6 ins. The committee, as a result of the guard-arm tests of 179 5 × 7-in. shanks and 58 6 × 6-in. shanks, has found that the increase in strength is as the ratio of 23 to 13, or a gain of 76%. Experience also shows that an increase in the dimensions of the head of the coupler is necessary, and this fortunately the committee can give, without seriously affecting any of the working parts of the car. The dimensions 8¾ ins. from the back to the lug to the inside face of the knuckle should be increased to 9¾ ins., thus allowing an increase of 1 in. or more in metal, through all parts of the head. The vertical dimensions of the knuckle through the knuckle pin hole have been increased to 8 ins., and of the lugs to 2½ ins., thus materially increasing the strength of all the parts. During the coming year your committee hopes to experiment with a head of these dimensions, and at the next meeting of the Association will be prepared to give some definite figures as to its relative strength.

DISCUSSION.—Mr. R. P. C. Sanderson opened the discussion by saying that he considered that the breakage of couplers was more due to their improper form than to lack of strength. He had also found that the breakage was greater on lines with sharp curves than the service seemed to warrant. He had purchased a number of various types of couplers and coupled them. He had found that in some cases the coupled couplers would permit a free lateral motion of 14° to each side of the center and that others would permit a similar movement of only 2½°. He urged therefore that attention should be paid to strict compliance with the established contour lines. He had found that the lateral away of the couplers on cars rounding curves was very great. Mr. C. A. Schroyer (Chic. & N. W.) stated that he had tested the lateral strains brought on couplers in rounding 12° curves varied from 3,000 lbs. to 57,000 lbs., the latter figure being obtained on sleeping cars with a large overhang. It was finally voted that the revised specifications submitted in the report should be submitted to letter ballot for adoption as recommended practice.

REVISION OF RECOMMENDED PRACTICE FOR SPRINGS, INCLUDING DESIGN FOR SPRINGS FOR 100,000-LB. CARS.

The committee presented detail drawings for springs for 60,000-lb., 70,000-lb., 80,000-lb. and 100,000-lb. cars. The conditions of general interest governing the design of these springs were stated by the report as follows:

(1) Each complete cluster of springs has been considered as a unit, regardless of the number of individual coils contained in each cluster; this method of classifying the springs it is thought will cause less confusion than to classify every separate coil as in the present recommendation.

(2) Wherever possible the springs for the lighter cars are constructed of bars similar to those used for the heaviest cars by removing some or all of the interior coils. While this arrangement of springs does not give the exact height with loaded cars as would be the case if each class of spring were especially designed for the class cars for which it is intended, the difference is so sli that it has no practical influence.

(3) The stress in the steel has been calculated to be nearly uniform in all the bars when solid as practi dimensions will permit, and has been confined within t limits of 80,000 and 85,000 lbs. per sq. in., except in t springs for 100,000-lb. pedestal trucks, in which the li has been exceeded on account of the impossibility of d signing a satisfactory spring with a lower stress in t available space.

DISCUSSION.—It was voted that the recommend springs be submitted to letter ballot for adoption.

CAST-IRON WHEELS.

This committee was appointed to report on the matt of locating the inner face of cast-iron wheels to gag point; the thickness of metal between the bore and rin core, and to recommend minimum weights for wheels f use with 60,000-lb., 80,000-lb. and 100,000-lb. cars. I report was in abstract as follows:

(1) If the outside face of the hub next to the box pr jects 3 3-16 ins. beyond the gage point, it will allow clearance between the face of hub and box of 1 in. in th normal position. The lost motion between the journa the brass, the wedge and the box is about ⅝-in. The di mensions given above will afford a clearance of at leas ¾-in. between the hub and the box, when all the los motion between the journal, the wedge, the brass an the box is fully taken up. It is the opinion of the com mittee that this amount of clearance is sufficient and tha no good will be obtained by increasing or decreasing th amount of clearance.

(2) As to the thickness of metal between the bore and ring core, it is the opinion of the committee, based on actual experience, that any thickness greater than 1 in. is sufficient, and the committee would recommend that a thickness of 1¼ ins. between the bore and ring core after the wheel is bored, should be made standard for all sizes of wheels.

(3) As to the minimum weight of wheels for use under cars of 60,000, 80,000 and 100,000 lbs. capacity, it is the impression of the committee that this is intended to refer to wheels used for repairs of cars in interchange. On this basis the committee would recommend that the minimum weight of wheels used for this purpose should be as follows:

For 60,000 lbs. capacity cars	.....	550 lbs.
For 80,000 " " "	.....	590 "
For 100,000 " " "	.....	620 "

It is also recommended that commencing September 1, 1901, wheel makers should be required to have the nominal weight cast on them, and your committee recommends the following weights:

For 60,000 lbs. capacity cars	.....	575 lbs.
For 80,000 " " "	.....	600 "
For 100,000 " " "	.....	625 "

The committee would also call attention to the fact that in a number of cases wheel patterns have been increased in weight by plastering on material at points which do not serve to increase the strength of the wheel, but merely to attain in the cheapest way the object of furnishing wheels of a given weight. It is extremely important, in adopting a heavier wheel, to have the material so distributed that an actual increase in the strength of the wheel shall be obtained thereby.

DISCUSSION.—The discussion turned largely upon the recommendations of the committee concerning the weight of wheels. A number of members called attention to the fact that much heavier wheels were in service than those recommended. Mr. J. N. Burr (B. & O.) thought that there was less reason for heavier wheels than for wheels made of better material. The fact was that the reuse of car-wheel metal and its combination with poor new material for many years had reached a point where the material was greatly deteriorated. He thought that the time was approaching when the Association would have to regulate the quality of material used in wheels. As the result of these diverging opinions it was voted that the committee be continued another year.

UNIFORM SECTION OF SIDING AND FLOORING.

FLOORING is to be of two kinds—square-edged, dressed all over, or ship-lapped, dressed all over.

In explanation of these recommendations it is to be remembered that the lumber from which this flooring is to be made is commercial size, 2-in., sawed in thickness, and ranging from 5 ins. to 10 ins. in width. The mill men can furnish flooring of random widths ranging from 5 ins. to 10 ins. in the rough at a cheaper price than they can flooring of one uniform width, and as this 2-in. lumber of the width mentioned is commercial material, that which will not cut to lengths for car-builders' work, or does not come up to the specifications required for car building, can be cut and used for other building purposes. The lumber men assure us that the percentage of narrow stuff will be small as compared with the percentage of wide. Of course, it would not be expected that miscellaneous widths would be used in the same cars, but as the flooring is run through the mill, the different widths can be stacked separately, uniform widths being used on different cars.

It was suggested from several quarters that the ship-lap should be so arranged that the upper part would be 1-in. thick and the lower part ⅞-in. thick, so as to give greater wearing life to the floor. Your committee, however, felt that it was better not to do this, because it is desired to have the best surface up, and by making the ship-lap centrally, the best side can always be turned up, and thus make a better looking and better wearing floor, and it is assumed that when the floor is nearly worn down to the ship-lap, the flooring will have to be renewed, as it is then too thin for service in modern, heavy cars.

"SIDING, ROOFING AND LINING."—Your committee thinks it best to recommend that the same section of material be used for siding, roofing and lining, and that the tongue and groove be placed centrally, so that either side of the material can be used as a face side. The purpose of this is that both at the commercial and railway mills all the material of this character can be run through the planers and matchers without changing knives. Then it can be assorted according to quality, the best of it being used for siding, the less perfect for roofing, and the poorest quality for lining. By making the tongue and groove

TABLE I.—Showing Action Under Test of Various Brake Shoes Tested by the M. C. B. Committee on Brake-Shoe Tests.

Name of Shoe.	Area bearing start, %	Same normal area, %	Loss of weight during steel wheel, Oz.	Loss of weight tests chilled wheel, Oz.
[1]Lappin	41.44	7.96*	6	5
[2]Sargent U	....	....	..	..
[3]Streeter	47.18	92.8	4½	1¼
[4]Corning	43.50	99.1	5	1
[5]Herron	47.70	97.7	3	1
[6]Cardwell	45.51	94.5	7	4
[7]Ideal	49.20	100.0	1¾	3
[8]Cardwell	46.00	100.0	16	16
[9]Sargent U	46.50	90.0	8	3
[10]Composite	48.40	98.0	8	8
Diamond S	52.92	100.0	10	6
Diamond S	49.16	99.0	8	7

Remarks.—[1]Considerable amount of fine scale; [2]Shoe broke while wearing down; [3]Considerable amount of fine to flaky scale; [4]Small amount of flaky scale; [5]Small amount of fine scale; [6]Considerable amount of fine scale; [7]Small amount of fine to flaky scale; [8]Large amount of very fine scale; [9]Very large amount of fine scale on the steel wheel, same on the chilled wheel, only coarser; [10]Large amount of fine scale.

*Side of shoe rounded. Net width during test, 3¼ ins.

TABLE II.—Showing Coefficients of Friction Shown by Various Brake Shoes Tested by M. C. B. Committee on Brake-Shoe Tests.

Shoe.	Wheel.	Coeff. of Friction. Mean—A. %	Final—B. %
Lappin	Steel	20.45	28.37
	Chilled	24.87	31.26
Streeter	Steel	21.99	26.55
	Chilled	16.51	21.76
Corning	Steel	14.22	20.88
	Chilled	13.69	22.00
Herron	Steel	18.98	26.03
	Chilled	17.80	25.66
Cardwell	Steel	22.91	29.29
	Chilled	24.42	30.64
Ideal	Steel	14.13	21.05
	Chilled	17.46	24.36
Cardwell	Steel	18.72	24.50
	Chilled	27.29	31.47
Sargent U	Steel	16.78	23.74
	Chilled	16.16	28.85
Composite	Steel	20.66	28.67
	Chilled	25.86	30.41
Diamond S	Steel	17.13	27.86
	Chilled	18.90	30.46
Diamond S	Steel	18.12	25.39
	Chilled	20.63	28.46

ceiling we think the roofing and lining lumber can be used with the flat surface out, while for the siding it can be used with the beveled edges out. There is no waste of labor in doing this, because cutting the bevel edges requires a second pass through the machine and does not cost anything additional. This siding, roofing and lining is intended to be made from regular commercial 1-in. sawed stuff, and to be dressed from 6-in. and 4-in. widths to match up 5¼-in. and 3¼-in. By accepting material of the two widths and stacking them separately, this lumber can be obtained at a cheaper price and obtained more quickly. We find that it is the practice of many car builders to do this, they using material of one width only in one car, while for roofing and lining the lumber used does not make any material difference. It is true that more nails will be required with the narrower widths, and there will be some more loss with the narrower widths on account of the additional number of joints per car, but the mill men are prepared to furnish the material already matched for less money per thousand feet. The mill men claim that it is becoming very difficult to get large quantities of lumber of the right specifications in the greater widths, and it is believed to be wise at the present time to concede this point and agree to accept lumber for siding, roofing and lining made from the rough of the two widths, namely, 4-in. and 6-in.

DISCUSSION.—Mr. L. T. Canfield (Del., Lack. & Wn.) considered that a tongue and grooved flooring was preferable to ship-lapped flooring. Mr. J. J. Hennesy (C., M. & St. P.) agreed with Mr. Canfield. He also thought that 10 ins. was too wide for flooring. It was finally voted that the recommendations of the committee be submitted to letter ballot.

AIR-BRAKE HOSE SPECIFICATIONS.

The report presented a set of specifications which did not differ materially from those recommended in the paper by Mr. A. M. Waitt, read at the 1898 convention of the Association. They were in abstract as follows:

1. All air brake hose must be soft and pliable and not less than three ply nor more than four ply. These must be made of rubber and cotton fabric, each of the best of its kind made for the purpose; no rubber substitutes or short fiber cotton to be used.

2. The tube must be hand made, composed of three calenders of 1-32-in. rubber. It must be free from holes and imperfections in general and must be so firmly united to the cotton fabric that it cannot be separated without breaking or splitting in two. The tube must be a high quality of rubber and must be such composition as to successfully meet the requirements of the stretching test given below; the tube to be not less than 3-32-in. thick at any point.

3. The canvas or woven fabric used as wrapping for the hose to be made of long fiber cotton loosely woven, and to weigh not less than 22 ozs. per yd., and to be from 38 ins. to 40 ins. wide. The wrapping must be frictioned on both sides and must have in addition a distinct coating or layer of gum between each ply of wrapping. The canvas wrapping to be applied on the bias.

4. The cover must be of the same quality of gum as the tube and must not be less than 1-16-in. to ⅛-in.

5. Air-brake hose to be furnished in 22-in. lengths. Variations exceeding ¼-in. in length will not be permitted. Hose must be capped on ends with not less than 1-16-in. or more than ⅛-in. rubber caps. Caps must be vulcanized on, not pasted or cemented.

6. The inside diameter of all 1¼-in. air-brake hose must not be less than 1¼ ins. or more than 1 5-16 ins., except at the ends, which are to be enlarged 3-16-in. for a distance of 2¾ ins., the change from the smaller to the larger to be made tapering.

The outside diameters must be kept within the following dimensions: The main part of hose 1⅞ ins. to 2 ins.; the enlarged ends 2 1-16 ins. to 2 3-16 ins.

The hose must be finished smooth and regular in size throughout as stated above.

Test hose will be subjected to the following test: Test hose must stand for 10 minutes a pressure of 500 lbs. before bursting. Each hose must stand a shop test of 200 lbs. A section 1-in. long will be taken from any part of the hose and the friction determined by the force and the time required to unwind the hose, the force to be applied at right angles to line of separation with a weight of 25 lbs. suspended from the separated end; the separation must be uniform and regular when unwinding; the average speed must not exceed 6 ins. in 10 minutes. A 1-in. section of the rubber tube or inner lining will be cut at the lapped or fixed part, marks 2 ins. apart will be placed on it and stretched until the marks are 10 ins. apart, then released immediately. The piece will then be re-marked as at first and stretched 10 ins., or 400%, and will remain stretched 10 minutes; it will then be released and the distance measured between the marks 10 minutes after the release. In no case must test piece show defective rubber or show a permanent set of more than ¼-in. between the 2-in. marks.

THIRD SESSION.

At the opening of the session Mr. C. H. Quereau (D. & R. G.) presented a motion that a committee be appointed to report upon a standard method of cleaning triple valves, and also upon the prices to be charged for this work. This motion was carried by vote of the convention, which then proceeded to the consideration of the remaining special committee reports.

THE CHEMICAL COMPOSITION OF STEEL CAR AXLES.

At the convention of 1900 the objection was raised that the percentage of carbon (0.4%) required in the M. C. B. specifications for steel car axles was too high. The committee made a careful investigation of the evidence back of this objection, and reported against any change.

DISCUSSION.—The report was discussed by Mr. A. W. Gibbs (P. R. R.), Mr. A. T. Colby (Bethlehem Steel Co.) and others. An abstract follows:

Mr. A. W. Gibbs (P. R. R.)—It may be of interest to the association to know something of the service of axles purchased under its specifications. The first steel axles I know of in this country were introduced about 1861. I had occasion to test a number of those axles and they were very soft. Now, in changing from iron to steel axles, many supposed that a steel axle having qualities very much like the iron, possibly a little stronger, would be an ideal material, and there was no attempt made to deviate very far from the quality of the iron. The axles gave very bad results. They broke in detail, fractures starting on one side of the axle and generally working across.

It will be noted that when a steel axle is injured it is rare to find that it snaps, it is generally a detail fracture. We found that the fractures became so very serious that early in the 90's an investigation was made in regard to the steel axles running at that time. We found three things; first, that the axles were very small; second, that the material was not disposed in the best manner and the design was not correct; and, third, that the material was not regular, and we were getting all kinds of steel, some hard and some soft. We did not go into the chemistry at all and we were getting all kinds of steel as a consequence. In January, 1896, we introduced a specification in which we used more material—put it where it belonged—but more particularly we governed the chemistry and went to a very hard steel. I might say that some of the manufacturers objected very strongly to taking any responsibility for steel of that quality—claiming that it was too brittle. Since that time, January, 1896, the company has bought a little over 507,000 axles. All broken axles are sent into Altoona for examination and I have got just three. Those three axles were all made by one concern, two out of the same heat of steel, and all of them broke within a few months from the time of being put into service, and when we examined them we found there were large internal flaws which were produced in the process of hammering. The chemistry of the steel was all right, which shows you can make bad axles of very good steel. In addition to these axles that were broken, we had half a dozen which were burnt off, and their behavior does not seem to be any different than of other axles burned off. There is no evidence that those axles were brittle, but they were simply chewed off by the boxes. About the same time that we introduced the specification, we began making a number of fatigue tests, that is to say, circular specimens were pressed into flanges revolving in a horizontal position. The other end was loaded so that it produced definite fiber stresses on the material, tension on the top and compression on the bottom, and as fast as a specimen would break it would be taken out and another one put in. That thing has been running about five years now, and the results so far show that the maximum fiber stress is certainly high enough. We think a fiber stress of 22,000 and 24,000 lbs. does not give, as a rule, a life as long as we are after. When we get down to 21,000 lbs. we get a life so long that the end of the usefulness of the axle will result from wear and not from breakage, which is the point that we want to reach.

A number of objections have been raised to the present specifications. One of these is that the carbon is so high that in cooling the journals with water, breakage will occur. We have no evidence so far that that is the case. Our axles can be cooled off just like anybody else's axles. Some objections have been made to other points in the chemistry. It is claimed that the carbon as high as this makes the axles brittle and more liable to break than one that is softer.

When the specification was made the committee desired to adopt a chemical analysis which was safe and which would not bar out any special method of manufacture.

Mr. A. L. Colby (Bethlehem Steel Co.)—I am glad to see that your committee expresses itself so strongly in favor of not decreasing the carbon from that given in the specification, namely, 0.4%, and I very strongly second Mr. Gibbs' remarks in reference to the many disadvantages of using a soft or low carbon steel for material which in service is subject to rapidly alternating stresses.

In describing the three failures of steel axles on the Pennsylvania road, Mr. Gibbs mentioned that in two of them there were internal flaws in the steel, and he made the remark that that showed that steel of good analysis could make poor axles. I think he should have said that piped ingots should not be used in making axles, no matter how good the steel is chemically. If material is used that has a pipe in it, or an internal flaw, no amount of hammering or heat treatment will overcome the weakness due to that flaw. Mr. Gibbs stated that the chemistry suggested in their car axle specification was a chemical analysis intended not to bar out any special method of manufacture. Now, as a matter of fact, I think it would tend to do that, because Bessemer steel could not be made economically of 0.4% carbon and as low as 0.6% in manganese. I think this matter of chemistry ought to be changed somewhat in your specification. For instance, I see no reason at all for specifying silicon. You specify that the silicon should be .05%, but I am perfectly sure that if you should analyze every axle on your road you would not find more than half of them that were below .05% silicon. An evidence of the fact that it is unnecessary to specify silicon may be taken from the Pennsylvania R. R. specifications themselves, for they specify for car axles .05% silicon and for driving wheel axles 2% silicon. The Wabash R. R. has the same anomaly in their two specifications. A higher silicon than .05% gives a much better forging steel. Some manufacturers use more silicon and less manganese to obtain freedom from superficial blow holes, and some increase the manganese a little and lower the silicon. I think you should specify a limit in sulphur and phosphorus, which are injurious ingredients in steel but leave the manganese and silicon to the manufacturer. Then introduce a clause into your specifications stating that your steel axles shall be made by the open-hearth process. There are few if any Bessemer steel axles now made, and by specifying that the open-hearth process be used, you would practically limit the manganese and silicon, for the manufacturer will use no more of these expensive materials than necessary to insure sound steel.

There are a few railroads which specify that the copper in the steel shall not be over .03%. If your car axles were analyzed for copper in your railroad laboratories it would be found that this requirement is also a dead letter, for a good deal of the steel furnished east of the Alleghanies contains over .03% in copper, and there is no evidence that it is detrimental to the steel; in fact, such evidence as does exist is the other way. The influence of copper in steel is a subject to which I have given a good deal of personal attention. There is one place in France where copper is intentionally added to steel to increase its strength; and such a low percentage as .03% is not prejudicial, and should not be made the subject of specification. In fact, we ought to try in our specifications to drop out the "dead wood." Make them as simple as possible and make the manufacturers live up to the specifications.

REVISION OF RULES FOR LOADING LONG MATERIALS.

The committee submitted a revised code of rules and recommended that two committees be appointed to report at the next convention on: (1) Rules for Loading Long Materials in Box or Closed Cars; (2) Safety Chains, Their Design, Location and Method of Attachment to Flat and Gondola Cars.

DISCUSSION.—The discussion on this report related chiefly to methods of detail in the proposed rules and to the recommendations made by the committee. It was voted that the proposed rules be submitted to letter ballot for adoption, and that the subject of appointing the two committees suggested in the report be referred to the Executive Committee for consideration. Mr. W. E. Symons (Plant System) made a motion that a committee to be appointed by the Executive Committee be instructed to co-operate with the transportation officials as to the loading of lumber on cars in the lumber-carrying districts, with a view to arriving at some definite methods of determining the weights of lap lumber shipments, and also that this committee co-operate with the American Railway Association. This motion was passed by vote of the convention.

MISCELLANEOUS REPORTS.

The Executive Committee reported that it had estimated the cost of indexing the proceedings and the printing of the index to be $1,500, and it recommended that the index be prepared. The recommendation was adopted by vote of the convention. The committee appointed to consider the "establishment of a joint library in connection with the American Railway Master Mechanics' Association" recommended that such a library should not be established at present. The recommendation was adopted by vote of the convention. The committee on "Side Bearings and Center Plates" reported progress and asked to be continued. It was voted by the convention to continue the committee another year.

DRAFT GEAR.

The report of this committee is published separately, together with the discussion upon it on another page of this issue.

ELECTION OF OFFICERS.

The following officers were elected for the ensuing year: President, J. J. Hennessey; First Vice-President, J. W. Marden; Second Vice-President, F. W. Brazier; Third Vice-President, T. W. Appleyard; Treasurer, John Kirby; Members Executive Committee, Geo. W. Delnarest; Wm. Renshaw, J. T. Chamberlain.

REDUCING THE WIDTH OF PAVEMENT ON RESIDENCE STREETS.

The advantage of reducing the width of the pavement on residence streets in cities of moderate size was brought forward in a contribution and editorial discussion in our issue of May 16. In "The Michigan Engineer," the annual publication of the Michigan Engineering Society, we find the following notes upon the same topic, presented by the President of the Society, Mr. H. E. Riggs, in discussing the subject of Roads and Paving:

The width of paving is a matter that the ordinary councilman and the ordinary citizen know little or nothing about. In Wauseon, O., Main Street is 72 ft. in width between curbs, with no street railway on it. I advocated a 60-ft. pavement, that being more than ample for the needs of the village. Wauseon is the county seat of Fulton county, a very nice little village of 2,500 or 3,000 inhabitants. The 72-ft. pavement, however, was put in. The council wanted it 80 or 85; their street is 100 ft. wide, with 10 ft. on each side additional by reason of the buildings being set back. A light fall of snow shortly after the pavement was finished showed very nicely the width of pavement they really required. Three days after that snow fall, I took the council over that street, and all of the traffic that had passed over it could have been handled very nicely on a 32-ft. street. At the sides the snow was unbroken, excepting where a pedestrian or a dog had walked across it. At Delta, a small village of perhaps 1,000 inhabitants, 18 miles west of Toledo, the main street is 50 ft. wide. They have something like a mile of street paving under contract, and the width settled upon is 18 ft. for streets which have little travel and no teams hitched on them, and 24 ft. and 30 ft. on the business street. Thus far it has been found that these widths are ample, and the paving has been put in at a very low cost to the property owners. The mistake is very often made by property owners of paving a street for 30, 40 or 50 ft. width where a 24-ft. or 30-ft. street would do just as well.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

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ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER, Cleveland, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 170 SUMMER ST.
CLEVELAND OFFICE, OSBORN BUILDING.

FOREIGN AGENTS.

C. MITCHELL & Co, Snow Hill, Holborn Viaduct, LONDON.
RUDOLF MOSSE, BERLIN and HAMBURG, GERMANY.
JOHN F. JONES, & CIE. 31 Rue de Faubourg Montmartre, PARIS.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2.50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.60 (31 *shillings*); *Thin Paper Edition, One Year,* $6.31 (26 *shillings*). *SINGLE COPIES of any number in current Volume,* 15 *cents.*

In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 321 *means that subscription is paid to the* 32*d week (that is the issue of Aug.* 8) *of the year* 1901; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

The failure of the $9,000,000 water loan at Philadelphia will probably cause some delay in portions of the works for the introduction of filtered water. This delay, however, should not be a long one, since it is supposed that a new loan ordinance, providing for a higher rate of interest, will be all that is necessary to secure the needed money. The rate of interest on the proposed loan was 3%. It is said that this low rate, coupled with the fact that other large loans are to follow, was responsible for the failure of the loan. It has been suggested that the conduct of the mayor and city council, in rushing through valuable street railway franchises, without compensation to the city, was in part responsible for the lack of bids for the loans, but this theory does not seem to meet with much support. It does not seem to have occurred to the Philadelphia public that the water loan need not have been anything like its present and proposed size if some effective steps were taken to cut down the water waste, and thus reduce the capacity and cost of the additions and improvements to the water supply.

The need of better training for municipal health officers and of permanency of office during good behavior and competency is urged in the last number of the "Ohio Sanitary Bulletin." Among other things the article in question says:

> There is no training school for health officers, in this country, except the health office itself. While medical colleges teach hygiene, the course of instruction is too short and too narrow to fit a man for a health officership. This will probably always be so, for the training in hygiene suitable for the general practicioner of medicine is not, except in part, that which the health officer requires. An efficient health officer is the work of years, and a community that has found a suitable man and trained him for this important office should not allow him to be replaced through political interference.

In our opinion, a course in sanitary engineering in one of out best engineering schools is a far better preparation than any medical school gives for the work of a health officer. Such a course combines a thorough grounding in sanitary chemistry and biology, as well as engineering and the sciences. The bulk of the work of a well-organized health department is concerned with the sanitary protection of the water, milk, meat and other food supplies of a community, together with safe plumbing and gas-fitting, the disposal of organic wastes, and isolation and disinfection to prevent the spread of communicable diseases. Both the diagnosis and treatment of communicable diseases are left entirely to private medical practice, except in cases of doubtful diagnosis or poverty. Doubtful cases may be referred to a consulting medical expert, or in larger places, to a special medical health officer. The department of charities naturally assumes charge of dependent cases. But none the less, the best part of the health officer's training, whatever his school education, he gets in performing the duties of a health officer, on which account the longer the period of service of an efficient man the greater the reason for continuing him in office. Above all, neither politics nor aspirations to build up a private medical or other professional practice should be allowed to interfere with the important duties and grave responsibilities of the health officer.

The almost complete failure of American municipal engineers and officials in charge of roads and streets to keep any record of the traffic passing over the highways under their charge is a matter deserving attention. Without such data no adequate studies of the comparative qualities of different road and street paving materials can be made. We are pleased to note that the Office of Road Inquiries, U. S. Department of Agriculture, has prepared and stands ready to supply to proper applicants blank forms for "Recording Volume and Character of Traffic" on highways. Provision is made for eleven different classes of vehicles. The directions state that records for less than a week are unsatisfactory, and that the records should cover as many seasons of the year as possible.

Mr. Martin Dodge is director, and Mr. M. O. Eldridge is assistant director, of the Office of Public Road Inquiries, Washington, D. C. It may be added that that Road Material Laboratory, Division of Chemistry, stand ready to examine, free of charge, samples of proposed road materials. Mr. H. W. Wiley is chief chemist, and Mr. Logan Waller Page is special agent of this branch of work.

A possible opening for engineering students desirous of earning a little money and gaining some valuable experience during vacation periods is suggested by the two foregoing notes. A number of such students have been employed with good results as temporary house-to-house inspectors by at least one board of health, and there seems to be no reason why more work of the sort should not be done, nor why such young men should not be engaged to take the censuses of road traffic. Both lines of work would afford excellent subjects for college theses. Road censuses might be taken at different periods through the college year, and by the co-operation of two or more students, turn and turn, the monotony of the task might be relieved and at the same time the range of the records extended.

The value of such investigations to municipal authorities hardly needs to be urged upon the readers of this journal, and the means suggested for obtaining them has the double merit of cheapness and efficiency.

The bids for garbage disposal in New York on June 27 were just what were to be expected under the circumstances. Although the present contractor, the New York Sanitary Utilization Co., put in a bid for a yearly sum a little over two and one-half times as great—($232,000 against $90,000)—as what it has been receiving for the same work for the past five years, it was still much the lowest bidder. As we pointed out in our issue of June 20, contractors were given but ten days for the preparation of bids, and only 33 days were allowed to the successful bidder to install a plant with a daily capacity of 1,000 tons. Inasmuch as specifications for this work were prepared some eighteen months ago, the taxpayers of New York may justly ask why bids were not invited long since, thus permitting fair and full competition in bidding and ample time for the construction of disposal works? We do not pretend to say whether the greatly increased price asked by the present contractors is fair or extortionate, but it is evident enough that the conditions under which bids were invited were not such as to determine that point. Strangely enough, the amount of garbage reported as sent to the Barren Island reduction works has decreased, instead of increased, which still further magnifies the new unit price. We understand that the commissioner of street cleaning has recommended an award to the lowest bidder, but that the board of estimate and apportionment must approve or disapprove the award. In the latter event a re-advertisement would be necessary. We shall be surprised if Controller Coler and other members of the board do not ask some pointed questions before acquiescing in the award.

The contrast between trust prices for iron and steel to the home consumer and to the foreign consumer has been often set forth but so frequently denied that some actual figures may be of interest. A recent cable dispatch from England states that American wire rods are offered delivered in Manchester at £6 ($29.30) per ton. Market quotations in the United States are $39 per ton. Adding cost of freights, etc., it is clear that the wire rod maker is netting at least $15 per ton more profit from his American customers than from his foreign sales. It is not strange that the iron and steel magnates deprecate any interference with the tariff.

The Liquid Air Power & Automobile Co. is (or was) a Boston concern, whose alluring inducements to those who should invest in its stock were commented on in our issue of Sept. 14, 1899. A Boston press dispatch of June 28 states that a receiver has been appointed for this company, and that its assets are estimated at $7,500. Its capitalization was originally put at the modest sum of $5,000,000, and is now given as $1,500,000. It is to be hoped that the courts may institute a searching investigation into the methods employed in promoting this concern, with especial reference to the extent to which it obtained funds from confiding investors by its alluring advertisements, and the disposition that was made of such funds. The liquid air delusion, it is true, seems to have pretty well spent itself; but those who traded on the ignorance of confiding investors should not escape scot free.

Apropos of the above, there lies before us the recently-issued prospectus of a zinc and lead mining company, which wants to raise $10,000 by the sale of stock on which it promises an annual dividend of 200%! One quotation from the prospectus must suffice:

> The ore does not run in pockets or deposits, as in many of the Western mines, but in true fissure veins; proving the supply to be inexhaustible.

We trust the value of this contribution to the science of economic geology will be properly appreciated.

RECENT PRACTICE IN FREIGHT TRAIN BRAKING.

American railways have equipped over a million freight cars with air brakes. Statistics recently made public by the American Railway Association show that on Jan. 1, 1901, the railways which are members of that Association had 989,127 cars equipped with air brakes and 54,118 new cars under contract to be so equipped. This represents an investment of not less than fifty to sixty million dollars.

The progress in the application of air brakes to freight cars has undoubtedly been hastened by the Federal Safety Appliance law, enacted in 1893. That law, while it required all cars to be equipped with automatic couplers by a certain date, did not require that all cars should be equipped with brakes. Instead, the requirement was that freight trains operated after the given date must have a sufficient number of air-brake

cars to control the train. It thus happens that about 375,000 freight cars are still in service which are not equipped with air brakes.

It is a fact, nevertheless, that the equipment of freight cars with air brakes will eventually be made complete. As long ago as 1892, it was formally adopted as the opinion of the Association "that all cars of freight trains should be equipped with power brakes," and the statistics of the Association show that all new cars put under contract since 1897 have had air brakes applied. Nearly all of the 375,000 cars reported as still unequipped on Jan. 1 last are doubtless cars so old that it is not deemed proper to spend much upon them, and every year many thousands of these reach the limit of their useful life and find their end in the scrap heap. The complete equipment of all freight cars in service with air brakes, therefore, is only a question of a very few years.

At present, since all cars are not equipped with air brakes, it is common practice to bunch the air-brake cars next the engine in making up trains. This means an expense for additional switching movements so great in the aggregate that it would doubtless pay the railways well to eliminate non-air-braked cars from general traffic, even if other causes did not make it advisable.

Opinion is somewhat divided as to whether better results are obtained in operating a long freight train equipped with air throughout by using all the brakes or by using only those on the front part of the train. Difficulties can occur with either plan. In general, however, the roads operating over steep grades use brakes on every car, while the roads in comparatively level districts which can operate in general much longer trains use only a part of the brakes. This latter practice is really an outgrowth, however, of the period of partial equipment. When all cars in service have brakes, it can hardly be doubted that it will be as customary to use the brakes on every car of a freight train as it is now on every car of a passenger train.

When the air brake for freight cars was first developed, long trains were the exception and not the rule. The adoption of a standard 50-car train in the Burlington brake trials of 1887 was protested against by many on the ground that such long trains did not represent ordinary conditions. Events have since amply vindicated the wisdom of the committee's requirement. Everybody can see now that a brake which would succeed on a 25-car train and fail on a 50-car train would not fulfill the conditions of American railway service.

Valuable as the Burlington brake trials were, however, there are many things in the brake business which both manufacturers and railways have had to learn since by experience. It was an easy matter, for example, to operate a 50-car test train just fitted and in charge of a corps of experts and keep it supplied with air. It is quite another matter to make up a train of 50 cars at random in a railway yard, with train pipes and hose in all sorts of conditions, good, bad and indifferent, and keep it supplied with air.

The original air-compressor—or air-brake pump—for operating the Westinghouse brake had a 6-in. steam cylinder. This was changed to an 8-in. cylinder many years ago, and the present standard is a 9½-in. cylinder with a 10-in. stroke. Even this is objected to by some roads as insufficient to maintain the train-pipe pressure on very long trains; and the use of even a larger compressor has been advocated. There are, however, strong objections to a further increase in the size of the air-brake pump. The steam consumption of even the present standard size pump makes no inconsiderable draft on the locomotive boiler. It is commonly said, we are aware, that the air-brake pump works only after the brakes are applied to make a stop or to check speed on a down grade, and it uses steam, therefore, which would otherwise be blown out of the safety valve. This is true, so far as the pump supplies air for actually operating the brakes; but this is only part of the pump's work. In every train there is more or less leakage from the train pipe and its connections, and the pump must continually make good the loss from these. This work requires the steady running of the pump, and often takes steam from the boiler when it can not well be spared. Manifestly a mere increase in the size of the pump would make this drain so much the worse.

Another possible road for improvement would be the adoption of a more economical air-compressor. The ordinary locomotive air-brake pump is most extravagant in its use of steam. To secure better economy without sacrificing the simplicity and reliability which characterize the present machine, however, is a difficult task. Such an improvement may yet be made; but it is not yet available.

The best way, undoubtedly, to facilitate the use of air brakes on long trains is to maintain the brake apparatus in such good condition that leakage from it will be trifling. This, however, is a reform which must be effected by the railways jointly. Any one railway company can only do its part by keeping its own cars in good repair; and it has to haul the cars of a hundred other roads and take the equipment as it finds it. One railway, for example, may purchase an inferior brand of hose for train-pipe connections on its cars, saving thereby a small sum in the first cost or favoring some supply company in which an officer of the railway is interested. All the railways which haul these cars, wherever they may go, have to pay for compressing the air which is constantly wasted through such inferior hose.

Besides this, it is apparent that leaking hose or train pipes constitute a source of danger. In every air-braked train descending a grade, the air-brake pump must be able to make good the air used in successive applications of the brakes. If the air is used faster than the pump can supply it, the pressure will be exhausted, the brakes will no longer operate and the train will run away. The margin between the maximum capacity of the pump and the amount of air required for breaking purposes in descending a long grade may be called the margin of safety. It is clear that all leakage from the train pipe reduces by so much this margin of safety; so that on this account, too, the proper maintenance of the brake system is a matter of importance to all railways.

We have thus far spoken only of the necessity of keeping the train pipe tight and free from leaks. Besides this, cleaning and oiling the triple-valve and brake cylinder and regular adjustment of the brake gear to compensate for the wear of the shoes are well understood to be necessary to the proper operation of the brake. All these matters, unfortunately, appear to have been neglected by many railway companies.

Whatever the cause of such neglect, whether it be due to ignorance or the pursuance of a penny-wise economy; it ought to be eliminated. The railway investment in air brakes on freight trains already amounts to fifty to sixty million dollars. The completion of the equipment will bring this amount to eighty million dollars or more. The regular use of this equipment is obligatory by law, and its benefits and advantages are nowhere disputed. Evidently, then, it ought to be maintained such condition as to give the best results, and to operate at all times with the maximum of reliability and the minimum of expense.

LETTERS TO THE EDITOR.

Measurement of Percentage of Voids in Broken Stone or Gravel.

Sir: In looking over the specifications on page 64 of the annual report of the State Engineer and Surveyor of New York for 1900, I find under the heading "Voids in Concrete," the following directions:

The voids shall be determined by filling a 12-in. cubical box with *dry* crushed stone or gravel, placing this on accurate scales and weighing the water required to cover the contents.

On looking up other instructions I find in Byrnes' "Inspectors' Pocketbook," page 384, the following instructions:

Wet the loose material thoroughly, fill a vessel of known capacity with it, and then pour in all the water the vessel will contain. Measure the volume of water required and divide this by the volume of the vessel; the quotient represents the proportion of voids.

As noted above, the instructions in one case call for the aggregate to be dry, and in the other the directions state that it shall be thoroughly wet. It seems to the writer that the aggregate should be thoroughly wet before measurement, in order that its condition shall be representative of that found in actual concrete mixing.

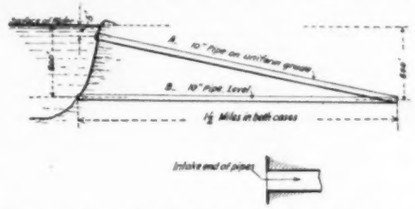
Respectfully yours, Walter Seely.

122 Woody Crest Ave., New York city, June 29, 1901.

(The wet aggregate gives the more accurate result; but there is no harm in specifying the dry method to give a little greater "factor of safety." —Ed.)

A Problem in Hydraulics.

Sir: There has arisen in this office quite a discussion in regard to the relative amounts of water that will be discharged by the pipes "A" and "B" under conditions



shown in the enclosed sketch. Would you kindly enlighten us on the following points:

(1) Both pipes are closed by valves at the lower end, giving pipes time to completely fill. If both valves are opened simultaneously, what will be the relative amount of water discharged by "A" and "B" for a short period of time?

(2) After the pipes have been flowing long enough to reach their normal flow, what will be the relative flow?

(3) At what depth below the surface of the water must the intake end of pipe "A" be placed to give the same flow as "B"? Respectfully,

A. S. B., Topographical Dept.

Third Ave. and Tremont St., New York, June 7, 1901.

[(1) Since under static conditions, the pressures at the lower end of the pipes will be the same, the volume discharged from the two pipes will, for a short time after the opening, be substantially equal.

(2) Whether A will continue to discharge as much as B when the flow becomes normal depends on two conditions: viz., (a) the relation between the friction in the pipe and its slope, and (b) the resistance to the entry of the water into the mouth of the pipe. Since the total head (the force tending to produce motion) and the total friction (the force tending to retard motion) are assumed to be the same in the two pipes, the amount of water delivered should be the same unless the force is so applied as to pull the water in one part of the pipe away from the water in the other. This actually occurs in pipes of very steep grade, and is made use of practically in the Sprengel vacuum pump, where the pipe is placed vertically. The square entrance of the pipe will exert a material retarding effect on the water passing through it. In answer to (3) it may be said that the intake end of the pipe A should be so far below the surface of the water that the head from there to the surface will be in the same proportion to the total head that the resistance of the water to entrance is to the total resistance (entrance resistance plus pipe friction).—Ed.]

A Plea for Better Roads at Less Cost.

Sir: In your issue of June 6, you have given us some very interesting matter upon the extremely important subject of roads. You seem, however, to assume that the destructive use which roads and streets now sustain, which fixes the requirement as to their strength, thickness, and consequent expense, can never be corrected. You seem to proceed entirely upon the idea that it is necessary to spend more and more on roads and streets in order to reduce the cost of traffic.

Of course, this is true in one sense, but in another, and a more important sense, it is not true at all. Assuming and asserting, that it is no expense to so change wheels as to make them wear road surfaces and themselves less, hence to roll easier, I claim and charge that there is neither a road nor a street surface in this country which cannot be bettered at less than no expense.

Mr. Whinery touches the vital point when he speaks of "concentrated wheel loads." We should see that wheel loads are less concentrated. Proper regulation of wheel width (per ton of pressure between contact surfaces of wheels and road) would probably have a considerable effect in lessening the thickness of metaling required for the road, but the really important effect would be to greatly reduce wear and tear and consequent power required for hauling.

For a given (say a proper) distribution of wheel load at point of contact of wheel and road surface, any lack of

PROPOSED STANDARD SPECIFICATIONS FOR STEEL FOR BRIDGES, SHIPS, FORGINGS AND RAILWAY RAILS.

As noted in another column, a series of standard specifications for steel for various purposes has been definitely formulated by a committee of the American Section of the International Association for Testing Materials. These specifications are the result of nearly two years' work by the committee, and have been informally approved by the Section. They are presented as fair general specifications for steel for the various purposes named. Altogether, nine different specifications have been prepared, as follows: Structural Steel for Buildings; Structural Steel for Bridges and Ships; Steel Rails; Steel Forgings; Steel Axles; Steel Splice Bars; Open Hearth Boiler Plate and Rivet Steel; Steel Castings, and Wrought Iron. We present here, as of the most general interest, the specifications for Structural Steel for Bridges and Ships; Structural Steel for Buildings; Steel Forgings and Steel Rails:

STRUCTURAL STEEL FOR BRIDGES AND SHIPS.

(1) Steel shall be made by the open-hearth process.

(2) Each of the three classes of structural steel for bridges and ships shall conform to the following limits in chemical composition:

	Steel made by the acid process.	Steel made by the basic process.
	%	%
Phosphorus shall not exceed.....	0.08	0.06
Sulphur shall not exceed.....	0.06	0.06

(3) There shall be three classes of structural steel for bridges and ships, namely: Rivet steel, soft steel, and medium steel, which shall conform to the following physical qualities:

(4)	Rivet steel.	Soft steel.	Medium steel.
Tensile strength, lbs., sq. in.	50,000 to 60,000	52,000 to 62,000	60,000 to 70,000
Yield point, in lbs. per sq. in., not less than.....	½ T.S.	½ T. S.	½ T. S.
Elongation % in 8 ins. not less than	26	25	22

(5) For material less than 5-16-in. and more than ¾-in. in thickness, the following modifications shall be made in the requirements for elongation:

(a) For each increase of ⅛-in. in thickness above ¾-in., a deduction of 1% shall be made from the specified elongation.

(b) For each decrease of 1 1-16-in. in thickness below 5-16-in. a deduction of 2½% shall be made from the specified elongation.

(c) For pins made from any of the three classes of steel, the required elongation shall be 5% less than that specified in paragraph No. 4, as determined on a test specimen, the center of which shall be 1 in. from the surface.

(6) Eye-bars shall be of medium steel. Full-sized tests shall show 12½% elongation in 15 ft. of the body of the eye-bar, and the tensile strength shall not be less than 55,000 lbs. per sq. in. Eye-bars shall be required to break in the body, but should an eye-bar break in the head, and show 12½% elongation in 15 ft. and the tensile strength specified, it shall not be cause for rejection, provided that not more than one-third of the total number of eye-bars tested break in the head.

(7) The three classes of structural steel for bridges and ships shall conform to the following bending tests; and for this purpose the test specimen shall be 1½ ins. wide, if possible, and for all material ¾-in. or less in thickness the test specimen shall be of the same thickness as that of the finished material from which it is cut, but for material more than ¾-in. thick the bending-test specimen may be ⅛-in. thick. Rivet rounds shall be tested of full size as rolled. (d) Rivet steel shall bend cold 180° flat on itself without fracture on the outside of the bent portion. (e) Soft steel shall bend cold 180° flat on itself without fracture on the outside of the bent portion. (f) Medium steel shall bend cold 180° around a diameter equal to the thickness of the specimen tested, without fracture on the outside of the bent portion.

(8) The standard-test specimen of 8-in. gage length shall be used to determine the physical properties specified in paragraphs Nos 4 and 5. The standard shape of the test specimen for sheared plates shall be as shown by the following sketch (Fig. 1).

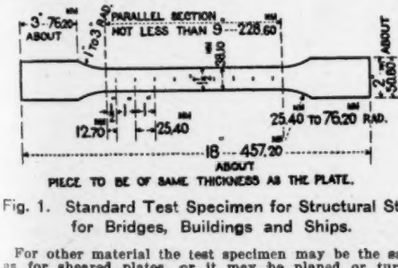


Fig. 1. Standard Test Specimen for Structural Steel for Bridges, Buildings and Ships.

For other material the test specimen may be the same as for sheared plates, or it may be planed or turned parallel throughout its entire length and in all cases where possible, two opposite sides of the test specimens shall be the rolled surfaces. Rivet rounds and small rolled bars shall be tested of full size as rolled.

(9) One tensile-test specimen shall be taken from the finished material of each melt, but in case this develops flaws, or breaks outside of the middle third of its gaged length, it may be discarded and another test specimen substituted therefor.

(10) One test specimen for bending shall be taken from the finished material of each melt as it comes from the rolls, and for material ¾-in. and less in thickness this specimen shall have the natural rolled surface on two opposite sides. The bending test specimen shall be 1½ ins. wide, if possible, and for material more than ¾-in. thick the bending test specimen may be ½-in. thick. The sheared edges of bending-test specimens may be milled or planed.

(11) Material which is to be used without annealing or further treatment shall be tested for tensile strength in the condition in which it comes from the rolls. Where it is impracticable to secure a test specimen from material which has been annealed or otherwise treated, a full-sized section of tensile-test specimen length, shall be similarly treated before cutting the tensile-test specimen therefrom.

(12) For the purpose of this specification, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gage of the testing machine.

(13) In order to determine if the material conforms to the chemical limitations prescribed in paragraph No. 2 herein, analysis shall be made of drillings taken from a small test ingot.

(14) The variation in cross section or weight of more than 2½% from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations:

(h) Plates 12½ lbs. per sq. ft. or heavier, up to 100 ins. wide, when ordered to weight, shall not average more than 2% variation above or 2½% below the theoretical weight. When 100 ins. wide and over 5% above or 5% below the theoretical weight.

(i) Plates under 12½ lbs. per sq. ft., when ordered to weight, shall not average a greater variation than the following:

Up to 75 ins. wide, 2½% above or 2½% below the theoretical weight. 75 ins. wide up to 100 ins. wide, 5% above or 3% below the theoretical weight. When 100 ins. wide and over 10% above or 3% below the theoretical weight.

(j) For all plates ordered to gage, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

Table of Allowances for Overweight for Rectangular Plates When Ordered to Gage.

Plates will be considered up to gage if measuring not over 1-100-in. less than the ordered gage. The weight of 1 cu. in. of rolled steel is assumed to be 0.2833 lbs.

Plate ¼-in. and over in thickness.

Thickness of plate.	Width of plate—Up to 75 ins.	75 to 100 ins.	Over 100 ins.
In.	%.	%.	%.
¼	10	14	18
5/16	8	12	16
⅜	7	10	13
7/16	6	8	10
½	5	7	9
9/16	4½	6½	8½
⅝	4	6	8
Over ⅝	3½	5	6½

Plates under ¼-in. in thickness.

Thickness of plate, inch.	Width of plate—Up to 50 ins., %.	50 ins. and above, %.
1/16 up to 5/32	10	15
5/32 " 3/16	8½	12½
3/16 " ¼	7	10

(15) Finished material must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

(16) Every finished piece of steel shall be stamped with the melt number, and steel for pins shall have the melt number stamped on the ends. Rivets and lacing steel, and small pieces for pin plates and stiffeners, may be shipped in bundles, securely wired together, with the melt number on a metal tag attached.

(17) The inspector representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

STRUCTURAL STEEL FOR BUILDINGS.

The specifications for structural steel for buildings correspond with those for bridges and ships, with the following exceptions: Bessemer steel is allowed as well as open-hearth steel; soft steel is excluded, and specifications for eye-bars are omitted.

STEEL RAILS.

1. (a) Steel may be made by the Bessemer or open-hearth process.

(b) The entire process of manufacture and testing shall be in accordance with the best standard current practice, and special care shall be taken to conform to the following instructions.

(c) Ingots shall be kept in a vertical position in pit-heating furnaces.

(d) No bled ingots shall be used.

(e) Sufficient materials shall be discarded from the top of the ingots to insure sound rails.

2. Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	Per cent. of—Carbon.	Not to exceed—Phosphorus.	Silicon.	Manganese.
50 to 59 + lbs.	.0.35—0.45	0.10	0.20	0.70—1.00
60 to 69 + lbs.	.0.38—0.48	0.10	0.20	0.70—1.00
70 to 79 + lbs.	.0.40—0.50	0.10	0.20	0.75—1.05
80 to 89 + lbs.	.0.43—0.53	0.10	0.20	0.80—1.10
90 to 100 lbs.	.0.45—0.55	0.10	0.20	0.80—1.10

3. One drop test shall be made on a piece of rail not more than 6 ft. long, selected from every fifth blow of steel. The rail shall be placed head upwards on the supports and the various sections shall be subjected to the following impact tests.

Weight of rail, lbs. per yd.			Height of drop, ft.
45 to and including	55	.....	15
More than 55	"	65	 16
" 65	"	75	 17
" 75	"	85	 18
" 85	"	100	 19

If any rail break when subjected to the drop test, two additional tests will be made of other rails from the same blow of steel, and if either of these latter tests fail all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted. If the rails from the tested blow shall be rejected for failure to meet the requirements of the drop test as above specified, two other rails will be subjected to the same tests, one from the blow next preceding, and one from the blow next succeeding the rejected blow. In case the first test taken from the preceding or succeeding blow shall fail, two additional tests shall be taken from the same blow of steel, the acceptance or rejection of which shall also be determined as specified above, and if the rails of the preceding or succeeding blow shall be rejected, similar tests may be taken from the previous or following blows, as the case may be, until the entire group of five blows is tested, if necessary. The acceptance or rejection of all the rails from any blow will depend upon the result of the tests thereof.

4. The drop-test machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rail shall be placed head upwards on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs. and the supports shall be a part of, or firmly secured to, the anvil.

5. The manufacturer shall furnish the inspector, daily, with carbon determinations of each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel. These analyses shall be made on drillings taken from a small test ingot.

6. Unless otherwise specified, the section of rail shall be the American Standard recommended by the American Society of Civil Engineers, and shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with paragraph No. 7, relative to specified weight. A variation in height of 1-64-in. less and 1-32-in. greater than the specified height will be permitted. A perfect fit of the splice bars, however, shall be maintained at all times.

7. The weight of the rails shall be maintained as nearly as possible after complying with paragraph No. 6, to that specified in contract. A variation of ½% for an entire order will be allowed. Rails shall be accepted and paid for according to actual weights.

8. The standard length of rails shall be 30 ft.; 10% of the entire order will be accepted in shorter lengths, varying by even feet down to 24 ft. A variation of ¼-in. in length from that specified will be allowed.

9. Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall accurately conform to the drawing and dimensions furnished in every respect, and must be free from burrs.

10. Rails shall be straightened while cold, smooth on head, sawed square at ends, and, prior to shipment, shall have the burr, occasioned by the saw cutting, removed, and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

11. The name of the maker, the month and year of manufacture, shall be rolled in raised letters on the side of the web, and the number of the blow shall be stamped on each rail.

12. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

13. Rails that possess any injurious physical defects, or which for any other cause are not suitable for first quality, or No. 1 rails, shall be considered as No. 2 rails, provided, however, that rails which contain any physical defects which seriously impair their strength shall be rejected. The ends of all No. 2 rails shall be painted in order to distinguish them.

STEEL FORGINGS.

1. Steel for forgings may be made by the open-hearth, crucible or Bessemer process.

2. There will be four classes of steel forgings which shall conform to the following limits in chemical composition.

	Shall not exceed—Phosphorus. %	Sulphur. %	Nickel. %
Forgings of soft or low carbon steel..	0.10	0.10	...
Carbon steel not annealed.....	0.06	0.06	...
Carbon steel, oil temp'd or annealed.	0.04	0.04	...
Nickel steel, oil temp'd or annealed.	0.04	0.04	3 to 4

3. The minimum physical qualities required of the different sized forgings of each class shall be as shown in the accompanying table.

4. A speciment 1 × ½-in. shall bend cold 180° without fracture on outside of bent portion, as follows: Around a diameter of ½-in. for forgings of soft steel; around a diameter of 1¼ ins. for forgings of carbon steel not annealed; around a diameter of 1½ ins. for forgings of carbon steel annealed, if 20 ins. in diameter or over; around a diameter of 1 in. for forgings of carbon steel annealed, if under 20 ins. diameter; around a diameter of 1 in. for forgings of carbon steel oil-tempered; around a diameter of ½-in. for forgings of nickel steel annealed; around a diameter of 1 in. for forgings of nickel steel oil-tempered.

5. The standard turned test specimen, ½-in. diameter and 2-in. gage length, shall be used to determine the physical properties specified in paragraph No. 3. It is shown in the following sketch (Fig. 2).

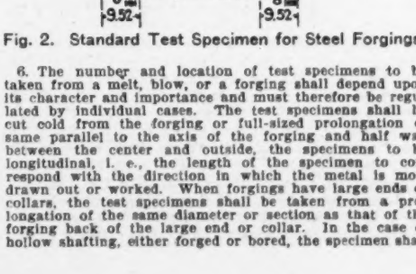


Fig. 2. Standard Test Specimen for Steel Forgings.

6. The number and location of test specimens to be taken from a melt, blow, or a forging shall depend upon its character and importance and must therefore be regulated by individual cases. The test specimens shall be cut cold from the forging or full-sized prolongation of same parallel to the axis of the forging and half way between the center and outside, the specimens to be longitudinal, i. e., the length of the specimen to correspond with the direction in which the metal is most drawn out or worked. When forgings have large ends or collars, the test specimens shall be taken from a prolongation of the same diameter or section as that of the forging back of the large end or collar. In the case of hollow shafting, either forged or bored, the specimen shall

wheel width must be made up for by extra length of bearing, which can be had only as the rim sinks (cut) to a depth varying, at the least variation, as the square of the ratio of the actual, plus the lacking width, to the actual width.

Of course, this quadruple or greater cutting for a double load or a halved wheel width, does not very often occur. However, I think it safe to say that for earth roads taken through all seasons, cases do occur where wheels actually succeed, through stress of bad weather, in cutting to the greatest limit indicated by theory; that is, about six times as deep for doubled load or half-width wheel, or eighteen times as deep for trebled load. This does not seem at all unreasonable to one who has known impassable roads and understands that the trouble is caused by lack of wheel width. The best road or best pavement is that which is best under the best conditions. We have never had such best conditions of use; hence we have never made the most of any road or street material. In short, however good we may make a pavement or road surface, let it be of any material whatsoever, asphalt, "asphalt-macadam," or granite-macadam, we shall not get the best (even that which cannot be bettered with less than no expense) until we support "heavy traffic," as well as light, upon wheels of light traffic width (per ton of pressure).

I am utterly at a loss to guess why so many persist in the losing game of seeking good roads without looking where alone they may be found, that is under properly wide wheels. J. M. Heiskell.

43½ Madison St., Memphis, Tenn., June 21, 1901.

(Wide tires are all right for earth roads, and to some extent for macadam roads. When tires exceed a certain width, however, they are likely to bear unevenly, the weight being thrown first on one edge and then on the other as the wheels pass over the more or less uneven surface of the road. The best authorities on road construction and maintenance, therefore, are quite conservative in their treatment of the wide tire matter.—Ed.)

The Recent Bid for the Sewering and Paving of Havana, Cuba.

Sir: The Engineering News of June 13 contains the prices of the bid received for sewering and paving this city, together with editorial notes thereon.

The blue-print schedule giving the bid received and the figures from this office was perhaps a little misleading, as the columns were not arranged in regular order, and our views in the matter were not precisely as stated in your editorial. We did not add 25% for contractor's profits and 40% and 50% in the paving and sewering, respectively, for contingencies, but intended both to cover both profits and contingencies, and prepared the two to show the relative difference in the totals. In other words, I had at first assumed that 25% would be sufficient to add to the actual estimated cost of the work, prepared with great care, to cover both contractor's profits and contingencies, 15% for the former and 10% for the latter. Later, however, it appeared that it might be proper to allow larger percentages for these items, as the work was to be done in a tropical climate, and the political situation is more or less uncertain. Accordingly, after the bid was received, I added the last column to the abstract, in which I allowed 40% on our actual estimated cost on the paving (20% for contractor's profits and 20% for contingencies), and 50% on the sewerage (20% for contractor's profit and 30% for contingencies, as these were likely to be greater in this case), using these large figures more for the purpose of comparing the result with the bid actually received than as intimating that I considered them proper percentages to allow for these items. I was careful to state in my report, recommending the rejection of the bid, that I did not wish to commit myself to recommending the acceptance of a proposal containing such large figures for these items, but stated that it would certainly be impossible for me to recommend the acceptance of a higher amount.

The total, according to our estimate, with these percentages added, was $11,061,427. The bid actually received (with the same unit quantities as for our estimate) was $13,718,253, or over $2,000,000 greater, and as there had been no competition, it was manifestly improper that it should be accepted.

With reference to the last part of your editorial, I would say that this office did not desire that the guaranty to accompany the bid should be as great as the $500,000 specified, nor was it thought that the bond should necessarily be as great as the $1,000,000 bond. These figures were inserted at the desire of the Ayuntamiento (city council.—Ed.), as they were in accordance with the Spanish law, which requires approximately 5 and 10% of the total estimated cost of the work for the guaranty and bond respectively.

You will have noted that the work has been re-advertised and bids will be opened again on September 25. A few changes have been made in the specifications. The most important is one allowing the submission of a certified check for $500,000 as a guaranty, instead of depositing that amount in cash or bonds 24 hours in advance of the date of opening the bids. The making of this deposit 24 hours in advance was believed to be inadvisable, as it gave bidders an opportunity of knowing, in advance of the opening of the bids, what parties were intending to bid, and accordingly allowed them a chance to combine or to change their figures.

With regard to your suggestion that it might be well to advertise the work in sections, I have to state that that question was carefully considered at the time the work was first advertised, and that for reasons beyond the control of this office it was deemed inadvisable to do so. I might also state that there were several instances in preparing the specifications when the requirements of the situation were such that this office was unable to secure the adoption of what seemed most advantageous from a purely engineering point of view.

Very respectfully, W. J. Barden,
1st Lieut., Corps of Engrs., U.S.A., Chief Engineer, City of Havana.

Havana, Cuba, June 22, 1901.

Concerning Asphalt-Macadam Pavements.

Sir: The writer has read with a great deal of interest Mr. Whinery's article on Asphalt-Macadam, and your editorial in reference to it in Engineering News of June 6, and we beg to call your attention to a misstatement in the editorial.

Mr. Whinery's plan of laying this new style of pavement is, as we understand it, to lay on the foundation a layer of crushed rock coated with asphalt, on which is placed a thin layer of bituminous composition similar to the surface mixture in ordinary asphalt sheet pavement, and the two are then combined by rolling with a heavy steam roller.

In the editorial this has been construed to mean the mixture of the two courses just described, before being laid, and in such a manner as to form a homogeneous bituminous concrete.

The writer agrees with you in your deductions based on this latter form of construction, but begs to call your attention to the fact that this method of construction is fully covered by letters patent No. 675,430, recently granted to Mr. F. J. Warren, President of Warren Brothers Co., 143 Federal St., Boston, Mass., and on which he has three more patents pending.

Mr. Whinery's method is similar to that which has been in use in Hamilton, Ont., for a number of years, and with little success, owing to lack of care in laying the pavement, and partly on account of the inferior quality of the bitumen used.

The writer doubts very much whether a homogeneous mass may be obtained by this method on account of the bituminous mixture becoming chilled so quickly, and partially on account of the uncertainty as to the size of the openings between the stones through which the mixture must be squeezed. That this result will be difficult to obtain will be seen by examining a piece of asphalt pavement laid with a binder course, in which it will be seen that very little of the asphalt mixture passes through the interstices of the binder stones.

Of course, if this bituminous mixture is laid in a thin layer, the result will probably be better, but the resultant pavement will probably be little more than an ordinary asphalt pavement with a binder course and having a very thin "wearing surface." It will be seen that if only as much bituminous mixture is spread over the binder stones as can be squeezed into the crushed stone by the steam roller, there will be some large voids in the bottom part of the crushed stone layer. The rolling action of wheels of vehicles passing over it and the action of the calks on the horses' shoes will probably work some of this mixture down into these unfilled voids in the course of time and leave the stones protruding above the surface, and these are very liable to become dislodged.

This conclusion is not based entirely upon theory, as such was the experience in the work done in Hamilton, Ont. They endeavored to overcome this by making the bituminous mixture soft in the hope that it would squeeze down into the stones better and they also left a surplus on top to take the place of any which was worked down by traffic; but this made the surface of the pavement soft and sticky, and it scaled off through having the road dirt gradually worked into it.

Mr. F. J. Warren's method of laying this bituminous macadam is the logical development of the asphalt-paving industry. The endeavor has always been in selecting sand for the top mixture of an asphalt pavement to secure the lowest possible percentage of voids without using a very large percentage of sand which would be held on the No. 40 sieve. By using such fine sand the percentage of voids of the paving mixture exclusive of the bitumen was rarely below 25%, and on account of the fineness of the sand, the surface of the grains to be coated was so large that even when enough bitumen was added to nearly fill the voids, the layer of bitumen on each grain was exceedingly thin, so much so that it took but very little disintegration of the bitumen to destroy the whole pavement.

Mr. Warren proceeded on the theory that by starting with large stones, say those which will pass through a 2-in. ring, and by properly grading the mixture down to an impalpable powder, a mixture could be obtained with a very low percentage of voids and with a very much smaller surface area of grains to be coated.

Experiments in this construction proved that it was easy to obtain a mixture of crushed stone and sand with as low as 10% voids and then with the small percentage of bitumen which it was necessary to use to fill these voids the thickness of the layer of bitumen on each grain was increased many times, owing to the bulk of the mixture being grains of a large size with small surface area as compared with an equal bulk of fine sand or limestone dust.

When this mixture is obtained it can be mixed into a homogeneous mass by a mechanical mixer and spread and rolled in the same manner as is usually employed in laying asphalt sheet pavements, and it is not necessary to depend on the uncertainty of trusting to the steam roller to do the mixing. Also the proper amount of each sized grains is secured instead of trusting to the rakers to spread the proper amount of the finer size on the street.

Another advantage, and a very important one, of Mr. Warren's method is the fact that a very much softer bitumen may be used in the wearing surface, which on account of its not requiring such high heats to work and lay the surface mixture, makes the cost of laying it very much less than that of a similar thickness of asphalt sheet pavement. Several pieces of pavement have been laid by this method and at a temperature of from 125° to 150° F., which is 150° cooler than sheet asphalt could be conveniently worked.

In an ordinary sheet asphalt pavement, the sand, being fine, has little rigidity in itself; or, in other words, if the mixture of sand and limestone dust were spread on the street without any bitumen, it would not sustain the weight of vehicles at all. But using the large stone mixed with the proper amount of fine material, the roadway formed of such a mixture would serve as a wearing surface in itself, if properly rolled, for such is the condition sought for in the ordinary macadam road. Thus the office of the bitumen ceases to be that of imparting rigidity to the mineral aggregate and it becomes the binding medium to take the place of the uncertain and unstable binding quality present in the ordinary macadam road.

The third advantage of using soft bitumen is its durability. An asphalt, or any other class of bitumen, even though comparatively stable when held at a temperature of say 300° F. for eight or ten hours, will, when exposed to the action of the sun and the elements in a thin layer such as on the surface of the mineral grains in a pavement, change its character through evaporation and oxidation, and this will in time harden the bitumen so as to destroy its cohesive properties. It will be readily seen that the softer the bitumen is to start with, the greater its life when subjected to the action of the elements.

It is also a well-understood fact that a comparatively unstable bitumen, such as coal tar, if properly confined and held in bulk, will have a very long life even when subjected to such conditions as would destroy a more stable bitumen exposed in very thin coats, as is the case in ordinary asphalt sheet pavements.

On account of the great density obtained in Mr. Warren's "Bituminous Macadam" these comparatively unstable bitumens may be used with great success as only that bitumen exposed to the action of the elements will decompose or lose its essential oils while the softer bitumen in the mass of the pavement will remain unchanged except that it will gradually give up its softening oils to the surface which has become hardened and bring the bitumen on the surface back to a flexible condition.

This gradual reviving of the bitumen on the surface by that underneath is very well illustrated in coal-tar concrete sidewalks so common in New England. These walks when first laid are quite soft, but by the end of the summer the surface has become coated with a thin skin of hard bituminous mixture, while in the spring following that hard skin is found to be quite soft again owing to the causes before mentioned.

The writer has endeavored to amplify the advantages of a bituminous concrete mixture as referred to in your editorial and has endeavored to draw the distinction between the method proposed by Mr. Whinery and that actually in use by Mr. Fred J. Warren, not, however, with any intention of detracting from Mr. Whinery's standing in the asphalt-paving industry. Mr. Whinery's reputation as an expert in this form of paving construction cannot be questioned, and the writer's four years' association with him in the asphalt-paving business warrants him in saying that there are few men to whom more credit is due for the development of the asphalt-paving industry than to Mr. Whinery. Very truly yours,

Howard W. Ash, M. E.

143 Federal St., Boston, Mass., June 10, 1901.

(Since the foregoing was put in type we have received a communication covering practically the same points, from Mr. F. J. Warren, whose name is mentioned in Mr. Ash's letter.—Ed.)

PLANS FOR TWO NEW BATTLESHIPS and two new cruisers are being prepared by the Board of Construction of the Navy Department to be submitted to Congress in December. The board has considered only the battleships so far, and has decided that they shall have a speed of 19 knots with a displacement of 15,000 tons. The question of building vessels of a still greater displacement was carefully considered, but the weight of evidence was that the displacement named was sufficient. It was found necessary to limit the speed to 19 knots in order to preserve the coal capacity and steaming radius.

Men may have the appearance of culture without its true spirit which is essentially honest. A class-room is no place to preach a sermon, but there can be there imparted a respect for truth and perfect honesty. A teacher's attitude should always be open and frank, that of a sincere seeker after truth. He should never dodge an honest question, and be ever ready to say "I do not know" if he does not.

Third. There can be no true culture for a man that does not put his cultivated powers to some useful service; and here there must be such degree of mastery over the chosen profession or business as will result in a special skill and dexterity. Here in early years the engineering student has the advantage of the student in arts. Study for knowledge's sake may be stimulating to the few, but for the many there is needed the goal of a special calling to secure the close application that results in ability to concentrate one's energy to the attainment of a certain end. But here again comes a danger, that of too early or over specialization, and the following of short cuts to professional life that are advocated by some, who, in the eyes of the world as well as in their own, have been eminently successful as specialists.

Fourth. In order to form conclusions that are appropriate and correct there is needed then breadth of view; a quality that has been expressed by the word poise. A man of poise, of even balance, will see things in their right relations and due proportions; he will weigh matters giving to each component part its just degree of importance. He will the better understand the motives that underlie other men's actions and the more readily use them to suit his own purpose. He will be more apt to rightly interpret the new movements in the world of thought or action and can seize opportunity for a personal advantage or a larger sphere of service before others see that there is such.

The value of mathematics and the physical sciences with their applications to technical things needs no discussion here for these are the engineer's tools; but it is a fair question whether in our desire to graduate students that can be early useful we do not place too much stress on technical things to the exclusion of others that give greater breadth of training.

Engineers have to deal with other things besides materials and physical laws; they must manage men and matters of finance. If they are to rightly influence those whose capital they are employed to expend, they must be able to meet them socially and intellectually, to discuss intelligently matters outside of the pale of strictly professional life. Evidence of professional ability and skill is of course first demanded, but breadth of culture creates an added confidence in the wisdom of the conclusions reached and the advice given.

Engineering practice is changing, as conditions become older and more settled and more and more practitioners find their work in communities and busy centers of trade where they are constantly thrown into close contact with strong and cultured men.

Fifth. It is not sufficient to form correct judgments only; there must be added a skillful and effective presentation of them in well chosen and fitting English.

The time given to English in our courses is not enough to properly train students in its use and at the same time open the doors to our best literature. It may be said that all of this English work should be done in the preparatory school, and it is probably true that the character and quality of the high school English is better today than it has been heretofore. Yet it seems to me that engineering students should have some training of a college grade along the line of literature.

Sixth. To the writer's mind, there is another element of culture that should enter into an engineer's training, viz.: an appreciation for beauty. The engineer is a designer, and it is important that he should embody his design in artistic form if he is to fulfill his whole mission and please and gratify others by the perfection of his work. The engineering student devotes a good share of his time to the drawing-board, and much can be done here toward the cultivation of this quality by an instructor who possesses it.

Seventh. The possession of agreeable manners and tact is another evidence of culture. Not merely the conventional bearing of polite society, though this has its value. This alone is but a husk which must cover the real kernel, refined and gentle feeling; and such feeling is the result of moral and intellectual convictions. The teacher's personality has very much to do with this matter. If he is of coarse grain, of domineering or selfish disposition, his influence will not tend toward the production of true gentlemen.

And now for the real question—does engineering education tend to produce culture? Science has modified and is still changing the ideas of culture that men hold. This much is clear, however, that no one existing course of educational training has a monopoly of cultural methods; nor will the completion of any college course necessarily secure its attainment, because of its personal quality. Further, culture is the result of life, and the most that can be expected of a college course is to open the student's eyes to its real worth, to start him rightly with certain leanings and aptitudes and furnish him with the means of a continuous growth toward its maturity.

It is maintained that an engineering course can tend in this direction, and that in some of our best colleges, under the instruction of people themselves cultured, it does so tend to-day.

As one looks forward ten or twenty years and attempts from present tendencies to forecast the work and social standing of engineers, he must see that the profession will be doing a larger work and exerting a greater influence and that an engineering training will be more and more recognized, as the one best fitted to lead to positions of an executive nature in connection with industrial enterprises, and in the administration of public works. Everywhere will be demanded expert skill, sound judgment and broad views, primarily because these will be found to be economical.

There are two tendencies in the present day engineering education that are, in my judgment, opposed to the desirable result. First, a tendency to crowd too much of the foundation work back upon the preparatory school, already overloaded. This Society's Committee on Entrance Requirements has advocated a standard which is high enough. Second, the allowing of technical subjects to crowd the fundamental general ones from the college course, in a vain attempt to do what from the very nature of the case cannot be done, make an engineer by college study. The result of this in some institutions is further seen in too early a differentiation between the various engineering courses; so that, for instance, the civil student knows nothing of applied electricity, and the electrical student nothing of surveying; while neither has a chance to acquire a taste for literature.

The whole problem is an involved and complicated one, but there is a way out that must be found if the engineer is to fill the important place that awaits him. One part of the solution will be found probably in a refining of the methods of instruction, so that better results may be reached in the same time. In the end, however, the writer thinks that there must come a deeper sense that after all life is long, that it should be taken with more of deliberation, and that it is the end that is important, rather than the beginning. The feverish rush and haste to be earning must be replaced by a recognition of the real necessity for a full rounded-out preparation if the largest and best service is to be given. Then the student will be glad to spend the one or two extra years in college that may be demanded. The wise student now will do this without its being required.

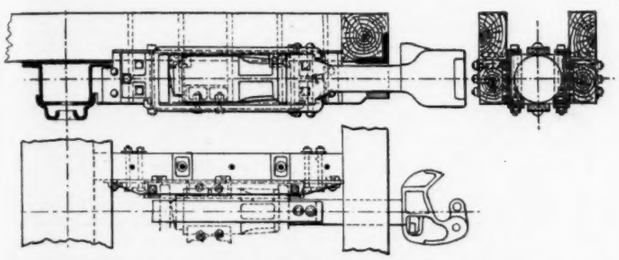


FIG. 2. WESTINGHOUSE FRICTION DRAFT GEAR APPLIED TO CARS WITH WOODEN SILLS AND STEEL BOLSTERS.

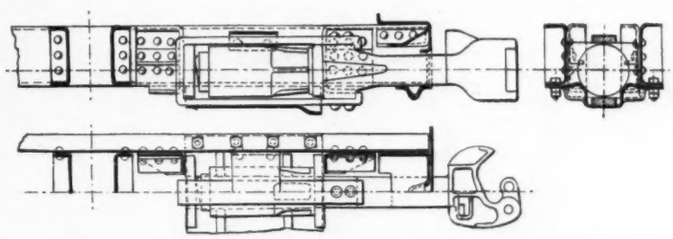


FIG. 3. WESTINGHOUSE FRICTION GEAR APPLIED TO STEEL CARS.

DRAFT GEAR FOR FREIGHT CARS.*

(With two-page plate.)

The subject assigned to your committee was as follows:

Draft Gear: To report on the requirements of modern freight car draft gear to meet modern conditions; methods of attaching to sills or cars; spring capacity; sizes and strength of parts, excluding the coupler, and to submit recommendations covering principles.

Owing to a number of unforeseen circumstances, the work of the committee was not begun as early as intended, with the result that all the work planned could not be carried out in time for a final report at this meeting. The work remaining relates chiefly to the testing of different draft gears and the submission of certain recommendations which can best be made after the tests are completed. It is proposed to make these draft gear tests this summer.

As regards draft gear for freight cars, the relative conditions now are very similar to what they were about ten years ago and prior to the adoption of the present recommended practice of the Association for coupler attachments. These conditions were clearly set out in a paper by Mr. C. A. Schroyer before the Western Railway Club in November, 1890, and a paper by Mr. D. L. Barnes in May, 1891, before the New York Railroad Club. Then, on account of increases in the size of trains, the strength of the draft rigging was being exceeded. It is believed that the present M. C. B. rigging has served a good purpose, but that the time has come when it must be strengthened to suit new conditions.

The draft gear failures which have been referred to in discussions during the past year seem to have been chiefly breakages of the old riggings, which were not designed for the work they are now called upon to do. So far as the committee has observed, several draft gears of recent design are showing good results in service. Of course, in considering any record of this kind, it must be borne in mind that most of these gears are practically new and also that they are favored by the large number of old cars with weak draft rigging, which fails first and so relieves the rest of the draft gear in the train. This is mentioned here because there seems to be an impression that most of the draft gears now being applied are inadequate, which has certainly not been demonstrated up to this time.

It is believed that in discussions a good deal of confusion has arisen from regarding the draft gear as a whole, and it is proposed to consider separately some of the component elements.

CAR DESIGN FAVORABLE TO THE DRAFT GEAR.—The use of metal underframing, allowing the draft attachments to be placed between and fastened direct to the sills, is looked on as one of the most important steps which can be taken in car design favorable to the draft gear. Experience so far has shown that with metal underframes the front and back follower stops can best be lugs united in one casting with heavy connecting ribs. This gives a large area in contact with the sills and permits of the use of an ample number of rivets. In several cases where single follower lugs have been used, concentrating the strains on a small area of the sill, the webs of the sills have been badly distorted, and in other cases, where the sills had been reinforced, these single lugs have been sheared off. The committee has heard of no cases of failure of sills where both lugs were on a single casting.

Some anticipate trouble from the greater rigidity of the metal frames. To compensate in the metal underframe for the greater elasticity of wood to absorb shocks, one road proposes to place the flanges of the center sills facing each other and put long timbers in between the flanges, extending the full length of the car. To these timbers the draft attachments are then bolted. Another plan is to use a channel end sill filled with a wooden timber, which carries the striking plate. Still another design, which is shown in Fig. 9, has been used on some Chicago & Alton cars. In this the draft gear in buffing is reinforced by high capacity spring resistance through a range of about ½-in. Another plan is to use spring buffers. The committee is of the opinion that the introduction of steel underframes will favor the draft rigging, eliminating the troubles from loose attachments due to the shrinkage of wood and the backing off of nuts.

What the committee considers an important principle is that with metal underframes, and wooden cars with low floors, the line of draft should be on the neutral axis of

*Abstract of a report presented to the Master Car Builders' Association at Saratoga, N. Y., June 24 to 26, 1901, by a committee consisting of E. D. Bronner, Chairman, C. M. Mendenhall, Mord. Roberts, T. A. Lawes and Geo. F. Wilson.

be taken within the finished section prolonged, half way between the inner and outer surface of the wall of the forging.

7. The specimen for bending test, 1 × ½-in., shall be cut as specified in paragraph No. 6. The bending test may be made by pressure or by blows.

8. The yield point specified in paragraph No. 3 shall be determined by the careful observation of the drop of the beam, or halt in the gage of the testing machine.

9. The elastic limit specified in paragraph No. 3 shall be determined by means of an extensometer, which is to be attached to the test specimen in such manner as to show the change in rate of extension under uniform rate of loading, and will be taken at that point where the proportionality changes.

10. Turnings from the tensile specimen or drillings from the bending specimen or drillings from the small test ingot, if preferred by the inspector, shall be used to determine whether or not the steel is within the limits in chemical composition specified in paragraph No. 2.

11. Forgings shall be free from cracks, flaws, seams or other injurious imperfections, and shall conform to dimensions shown on drawings furnished by the purchaser, and be made and finished in a workmanlike manner.

12. The inspector representing the purchaser shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.

Physical Qualities Required for Steel Forgings.

Tensile strength.	Yield point.	Elongation in 2 ins.	Contraction of area.	
Lbs. per sq. in.		Per cent.		
				Soft Steel or Low Carbon Steel.
58,000	29,000	28	35	For solid or hollow forgings, no diameter or thickness of section to exceed 10 ins.
				Carbon Steel, Not Annealed.
75,000	37,500	18	30	For solid or hollow forgings, no diameter or thickness of section to exceed 10 ins.
				Carbon Steel, Annealed.
	Elastic limit.			
80,000	40,000	22	35	For solid or hollow forgings, no diameter or thickness of section to exceed 10 ins.
75,000	37,500	23	35	For solid forgings, no diameter to exceed 20 ins. or thickness of section 15 ins.
70,000	35,000	24	30	For solid forgings, over 20 ins. diameter.
				Carbon Steel, Oil Tempered.
90,000	55,000	20	45	For solid or hollow forgings, no diameter or thickness of section to exceed 3 ins.

Tensile strength,	Elastic Limit.	Elongation in 2 ins.	Contraction of area.	
Lbs. per sq. in.		Per cent.		
				Carbon Steel, Oil Tempered.
85,000	50,000	22	45	For solid forgings of rectangular sections not exceeding 6 ins. in thickness or hollow forgings, the walls of which do not exceed 6 ins. in thickness.
80,000	45,000	23	40	For solid forgings of rectangular sections not exceeding 10 ins. in thickness or hollow forgings, the walls of which do not exceed 10 ins. in thickness.
				Nickel Steel, Annealed.
80,000	50,000	25	45	For solid or hollow forgings, no diameter or thickness of section to exceed 10 ins.
80,000	45,000	25	45	For solid forgings, no diameter to exceed 20 ins. or thickness of section 15 ins.
80,000	45,000	24	40	For solid forgings, over 20 ins. diameter.
				Nickel Steel, Oil Tempered.
95,000	65,000	21	50	For solid or hollow forgings, no diameter or thickness of section to exceed 3 ins.
90,000	60,000	22	50	For solid forgings of rectangular sections not exceeding 6 ins. in thickness or hollow forgings, the walls of which do not exceed 6 ins in thickness.
85,000	55,000	24	45	For solid forgings of rectangular sections not exceeding 10 ins. in thickness or hollow forgings, the walls of which do not exceed 10 ins. in thickness.

ANNUAL MEETING, AMERICAN SECTION, INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

The fourth annual meeting of the Section was held at Niagara Falls, N. Y., on June 29. President H. M. Howe opened the convention with a brief address, in which he remarked chiefly upon the relation of the work of the Association to the industrial life of the present day. The Secretary's report showed the membership of the Section to be 168 and its finances to be in a satisfactory condition. Then followed some minor routine business, after which the convention proceeded to its principal work. This consisted, first, in receiving and acting upon the Report of Committee No. I., charged with the duty of preparing standard specifications for iron and steel, and, second, in formulating a series of instructions to the American Member of the International Council, viz., Prof. H. M. Howe, to serve as a basis for his action upon certain questions and propositions which were to come up at the Buda Pesth meeting of the Association in 1902, and upon which the American Section desired action.

Comparison of the Physical Properties of Steel Forgings Determined on Test Bars of 2-inch. and of 10-inch Gage Length.

Items.	Tensile strength. lbs. per sq. in. 2″ bar.	Tensile strength. lbs. per sq. in. 10″ bar.	Elastic limit lbs. per sq. in. 2″ bar.	Elastic limit lbs. per sq. in. 10″ bar.	Extension Per cent. 2″ bar.	Extension Per cent. 10″ bar.	Cont. of area Per cent. 2″ bar.	Cont. of area Per cent. 10″ bar.
Engine forgings	86,580	88,800	49,910	50,220	28.00	17.00	58.06	51.00
Crank web	81,490	79,820	49,910	46,210	30.00	22.70	58.00	51.75
Link-beam pin	93,200	90,390	60,090	59,320	27.00	19.60	59.96	56.00
Crank pin	90,650	88,980	60,090	62,120	28.00	20.00	62.53	60.00
Engine forgings	91,670	89,740	59,080	62,370	28.50	18.00	60.55	55.00
Crank web	84,030	82,860	53,980	51,940	27.00	24.30	51.55	50.00
Crank web	89,120	86,440	53,980	53,200	27.00	21.30	54.83	53.00
Pin	94,600	94,330	60,330	62,880	26.00	19.80	52.73	51.00
Cross-head pin and collars	89,630	87,820	55,000	52,440	27.00	19.80	49.29	46.00
Main shaft and eccentric rod	89,990	91,530	52,150	56,520	25.50	20.00	46.48	49.30
Engine forgings	91,670	89,880	63,150	62,500	26.00	21.00	49.57	50.00
Engine forgings	92,190	91,020	62,120	61,980	26.50	19.80	47.57	44.00
Piston rod	90,140	85,290	51,950	52,950	27.00	19.00	58.00	55.00

REPORT OF COMMITTEE NO. I.—At the October, 1900, meeting of the Section the American Section of Committee No. I. submitted a series of standard specifications for iron and steel for various purposes. These specifications were very fully discussed, and a number of revisions were ordered made by vote of the members present. The committee was instructed also to prepare certain additional collateral work and to submit a revised report. This revised report was submitted at this meeting, and consisted, first, of a revised set of specifications and, second, of a series of investigations to determine the relative results obtained from test specimens 2 ins. long and from test specimens 8 ins. or 10 ins. long.

The revised specifications submitted were nine in number, and with three exceptions they were adopted by vote of the convention without further modification. The three exceptions were as follows: In the specifications for steel rails and steel axles a clause was added in each case to the section relating to drop tests, which required that a record be made of the temperature of the atmosphere in which the drop test was made. In the specifications for steel forgings, the maximum nickel content of nickel steel was changed from 3.75% to read from 3% to 4%. In the specifications for wrought iron, the clause specifying process of manufacture was amended by adding the charcoal-hearth process as being among the acceptable processes. In conclusion it was voted by the meeting that the specifications as finally revised be adopted as standard by the American Section, provided, upon letter ballot, 70% of the votes cast favored such action. In another column of this issue we present in full the specification for structural steel for bridges and ships; the specification for steel forgings, and the specifications for steel rails as they were revised by the convention and will be submitted to letter ballot for approval.

The portion of the report of the committee relating to standard turned test specimens 2 ins. long was as follows:

During the discussion of the specifications at the last annual meeting of this American Section, your Committee No. I was requested to submit a report at the next annual meeting, giving the reasons which had led them to recommend a test specimen of 2 ins. gaged length, for determining the physical properties of steel axles, steel tires, steel forgings and steel castings, and for testing large rounds of wrought iron, rather than a test specimen of an 8-in. or 10-in. gaged length, and to show the relation between the same materials tested in bars of the different sizes. The chairman of the committee appointed Mr. Albert Ladd Colby as a committee on this subject, who has presented the following report:

Sir: Much may be said in favor of the general adoption of the test specimen, shown in the following cut, of a gaged length of four diameters, for the commercial testing of these four classes of steel.

With axles and all steel forgings a much shorter prolongation of the forging is required for a longitudinal specimen of the above length than for a test specimen of 8-in. gaged length. The shorter specimen, therefore, requires the manufacturer to consign much less good metal to scrap, an item of considerable importance to the customer in the case of forgings of large diameters. Less time and labor is expended in cutting out and machining the shorter test specimen. At a given cost a much better idea of the quality of the metal can therefore be obtained, for several short specimens can be taken at different positions in an important casting or forging at the same cost for preparation as one long specimen.

The shorter specimen has also the great advantage of enabling the customer to determine the character of the material at places in a complicated casting or forging where there is not space enough for a longer specimen, as between the webs of crank shafts. In the case of steel tires, the shorter specimen is greatly preferable, for when cut from the rim of the tire used for the drop test, the longer specimen can very seldom be obtained unless the tire is heated and straightened, an operation which at once destroys its value as a representative test of the finished tires of the melt.

Finally, the physical properties called for in the specifications for steel castings, steel axles, steel forgings and steel tires can be accurately and readily determined when using the standard test specimen recommended. For in cases where elastic limit is specified instead of yield point, an apparatus reading to 0.0001-in. can be easily attached and readings readily made. The determination of the tensile strength is not materially affected by the length of the specimen. The percentage of contraction of area and the quality of the fracture, both very important factors in determining the quality of the metal, are shown with equal accuracy and distinctness with the shorter specimen, as with one of greater length. The higher percentages of elongation obtained on 2 ins. are compensated for by having correspondingly higher requirements in the specifications.

In proof of the above assertions, the writer submits the accompanying table, showing a series of comparative tests made with much care on the 300,000 lb. Emery hydraulic testing machine used by the Bethlehem Steel Co. In each case the tests were threaded on both ends and the elastic limit read with an electric micrometer.

Upon motion by Mr. Moldenke it was voted that the American Section of Committee No. I. be continued, with instructions to report upon standard specifications for steel sheets, steel tubes, steel wire, steel springs and cast iron.

INSTRUCTIONS TO MEMBERS OF COUNCIL.—Owing to the fact that a meeting of the International Association for Testing Materials will be held at Buda Pesth, Hungary, in 1902, at which the American Member of the Council will necessarily be present, the meeting considered it desirable that formal action should be taken as a basis of authority for the action of its representative in demanding certain privileges which the American Section deemed necessary to its work. These instructions were embodied in a resolution to the effect that: The American Section demanded absolute right to select its member to the International Council and to change this member at its will, and requested that such changes be made in the Statutes of the Association as would convey this privilege in constitutional form. It was further voted that the International Association be requested to authorize and establish a committee to report upon standard properties, tests and specifications for hydraulic cements; this committee to correspond in plan and scope of work to Committee No. I., having in charge specifications for iron and steel. It was also voted that the Association place English upon an equal basis with French and German in printing the work of the Association in its official journal "Baumaterialkunde."

COMMITTEE ON CEMENTS.—This committee submitted a brief report stating that it had completed an organization along much the same lines as the American Section of Committee No. I., and was proceeding with its work. It urged, however, the desirability of establishing the general committee specified in the above instructions to the American Member of the International Council in order that definite practical results might come from its work.

THE CULTURAL VALUE OF ENGINEERING EDUCATION.*

By F. O. Marvin,† M. Am. Soc. C. E.

There seem to be certain fundamental qualities which must be possessed before a man can be classed with cultured people, qualities which are only acquired after a considerable experience in life, but which are influenced greatly by the years of student training and therefore fit subjects for discussion here. Far be it from the purpose of this paper to attempt a definition of culture or a setting forth of its elements in any completeness; rather the emphasizing of some things that relate to it, especially with reference to the education of young engineers.

First. The man of culture must be a thinking and reflecting being. There must be not only the ability but the habit; and this is no easy thing to acquire. Modern American life is full of hurry, full of affairs that demand instant attention, and one matter follows another with rapid succession. Men seek short cuts to fortune. In the popular opinion, the men who act quickly, the men of decision, are those who succeed. But there is a danger here. Back of the action, behind the sharp decision, must lie a mature judgment, and how else is this to be formed except as a result of deliberate reflection? The decisive act which is also right rests on a process of thinking and judging that has been long fostered until it has become a habit, until there are established certain standards by which things are to be measured.

The early steps of this training are necessarily slow and we, as teachers of engineers, must recognize this and not yield to the temptation to crowd our students over too much ground on the one hand, or on the other to lead them through short cuts across country by empirical paths that may give them ease and quickness of travel, but little or no reason why the path is chosen. Let them go the long road. I do not by any means wish our teaching to be non-practical—rather more practical in the best sense; but first, last and all the time, let students be trained to do their own thinking and to form their own judgments; to test the statements of others by the workings of their own mental processes.

Second. There is another element of culture that comes in here, an ethical one, that of forming right judgments

*From the Presidential Address at the Annual Convention of the Society for the Promotion of Engineering Education.

†Dean of School of Engineering and Professor of Civil Engineering, University of Kansas, Lawrence, Kan.

Mr. Roberts (L. & N.) said that the committee had to meet conditions as they exist. Standard heights of draw-bar and standard diameters of wheels have been adopted which effectually prevents the raising of the center line of draft rigging. Probably 95% of the freight cars in service have draft sills below the main sills.

Mr. W. P. Appleyard (N. Y., N. H. & H.) thought the difficulty might be overcome by deepening the center sills, to bring them more nearly in line with the drawbars. He is designing some new cabooses in this way.

Mr. Sanderson thought the continuous draft-rigging principle was all right applied to a single car, but was wrong applied to a whole train. Unless springs are connected into this continuous chain of iron rods the whole forms a rigid iron chain running the whole length of the train. With the jerks which all train movement involves, any such rigid chain is bound to break.

Mr. L. T. Canfield (D., L. & W.) objected to raising the drawbar height, or to lowering the car floors. The latter would make loading at platforms more difficult. If buffer blocks were attached to such a car, they would be out of line with those now in service. It would also be harder to protect the angle valve of the brake pipe. He favored the present construction with draft sills below the main sills, but would carry the draft sills farther back.

Mr. F. H. Stark (C., L. & W.) said that experience showed a less cost of repairs with the underhung draft sill than with cars having the draft sill between the center sills. With this construction, accident to draft gear means injury to the center sill, and that is expensive to replace. He favored the sub-sill construction and had built cars in this way with these sills carried well back where the coupler head could be broken off or the car broken in two in the middle without damaging the draft timbers. Auxiliary rods in so-called continuous draft rigging are a mistake. Roads using them find no end to their stretching and causing shock.

Mr. W. E. Symons (Plant System) thought abuse of cars by rough handling in yards was the cause of a large part of draft-gear repairs. No materials or methods of construction can endure such abuse as cars are receiving to-day. Claim agents say that the claims for damage to goods in transit have increased 50% since the adoption of automatic couplers.

Mr. F. W. Brazier (N. Y. C. & H. R.) agreed with Mr. Symons as to the damage to cars by rough handling.

Mr. C. H. Quereau (D. & R. G.) said that the drawbar passing through the end sill was not so bad a type of construction as many seemed to think. He knew of several hundred cars built in this way, with the end sill reenforced for 3 ft., and no end-sill breakage had occurred except in case of a wreck.

Mr. T. H. Symington had had the greatest trouble with broken draft timber bolts. He had found that in keying the timbers together the keys would shrink and the whole strain was thrown on the bolts.

Mr. L. T. Canfield (D., L. & W.) favored the continuous draft rigging, but thought it should be in the form of a beam or channel. The auxiliary rod plan had proved a failure.

Mr. J. W. Marden (B. & M.) said that the M. C. B. draft rigging gave good results and the members would do well to adhere to it until something certainly better was found.

Mr. Pulaski Leeds (L. & N.) agreed with Mr. Marden as to the merits of the M. C. B. rigging. As far as continuous draft gear is concerned he saw no difference between a continuous draft gear made up of bolts or made up of sills. If the draft timber and rigging is firmly fastened to one end of the sills, they transfer the strain just as directly to the rear end of the car as though they were iron rods. If all the members would adopt the standard draft rigging as recommended by the Association a good many years ago they would reduce the expense of repairs to the rigging to a great extent.

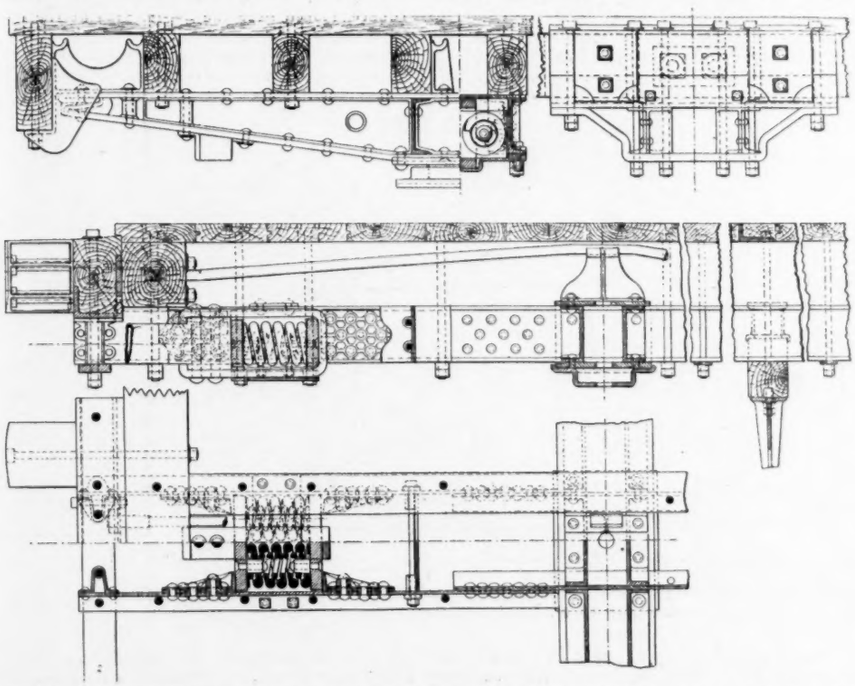


FIG. 25. EXPERIMENTAL DRAFT GEAR FOR HOPPER BOTTOM GONDOLA CAR; L. S. & M. S. RY.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The thirty-third annual convention of the Society was held at Niagara Falls, N. Y., June 25 to 28, inclusive. About 575 members and guests were registered as being in attendance. The sessions were held in the International Hotel, which was also the headquarters of the Society, and where the bulk of the members stayed. As was perhaps natural in view of the season and the augmentation of the regular summer travel by the influx of visitors to the Pan-American Exposition, desirable hotel accommodations were hard to find at anything like reasonable rates. Those who were fortunate enough to have booked their rooms in advance received the benefit of the advertised convention rates, but those who did not take this precautionary step in many cases were compelled to pay from $5.50 per day upwards for single rooms and inferior accommodations. The result was that a goodly number shortened their stay to the lowest possible limit of time, and the attandance during the last two days of the convention was reduced materially below the number registered at the opening session. It is but just to say that these conditions was beyond the control of the Local Committee, whose efforts before and throughout the convention to make the stay of the members pleasant and comfortable, deserved the thanks which were formally voted it.

The convention was opened by an address of welcome by Mr. Geo. C. Ricker in behalf of the Engineers Society of Western New York. President J. J. R. Croes then delivered his annual address, which we print, in part, on another page of this issue. The Secretary presented to the Society a number of invitations to visit points of local interest, and Maj. Thos. W. Symons invited the members to visit and inspect the work in progress on the new Buffalo breakwater, placing the official steam yacht used by his staff at their service for the trip. The convention then took up special business.

The first business was the reading by the Secretary of the Report of the Board of Direction on the appointment of a committee on Standard Rail Sections. The report reviewed briefly the reasons for and against such action and concluded by recommending that a committee be appointed with directions to report upon the results obtained with the standard rail sections at present recommended by the Society, and to report on practice in manufacture and chemical composition and particularly upon methods of inspection. The convention approved by vote the recommendation of the Board and also voted that the matter be submitted to letter ballot for final decision. The convention next took up the proposition to amend Article III. of the Society's constitution, relating to the admission and expulsion of members. After considerable discussion the matter was referred to a committee of seven members, one from each district, to be appointed by the president, and instructed to report to the annual meeting in January, 1902. The question of the time and place of the next annual convention was then taken up and a number of places were submitted for consideration. The largest number of votes favored Washington, D. C., and the matter was referred to the Board of Direction for final decision. This action closed the work of the first session. In the evening a lecture was given by Mr. Walter McCulloh on the bridges at and in the vicinity of Niagara Falls.

SECOND SESSION.—The program provided a number of topics for discussion as the business of the second day of the convention. The first topic was the advisability of legal restrictions to govern the practice of engineering. The discussion was opened by Mr. Samuel Whinery, who called attention briefly to the fact that at present any person was at liberty to take up the practice of civil engineering and that many persons were practicing in this capacity who were almost totally lacking in education and natural capacity for conducting engineering work. The well-qualified and trained engineer was compelled to submit to the competition of such persons, and to be classed with them in public estimation, since the public had no means of judging who were competent engineers and who were not. To provide this means of identification he proposed that legislation should be enacted restricting the practice of engineering to persons whose qualifications had been ascertained by some competent authority. He thought the matter was one for state legislation rather than national. Such legislation should be carefully devised to prevent any injustice to individuals and should be uniform throughout the country. In his opinion this legislation should be formulated along the following broad lines: First, the law should define accurately what was meant by the term civil engineer; second, a state board of examiners to consist of five members appointed for a term of five years should be appointed by the Supreme Court to examine into the fitness to do so of all persons who desired to practice civil engineering; third, there should be three classes of licenses. The first would be given only to persons who had attained a good degree of prominence in the profession; the third should be given to graduates just out of the engineering schools and to other beginners in professional practice, and the second should be given to those occupying a middle position between these two. Fourth, no person should be permitted to practice engineering without a license.

Mr. Foster Crowell thought that all would agree upon the desirability of eliminating from the profession of engineering all persons who were incompetent and untrained. He believed that the matter was one to be handled by national legislation rather than by state legislation, since it was practically impossible to secure uniformity in state laws. He also doubted if the time was ripe for legislation of any sort upon the question. Mr. F. C. Osborn considered that the conditions demanded restrictive legislation and suggested that a committee of the Society be appointed to consider the matter. Mr. H. W. Brinkerhoff thought that so far as the protection of the public was concerned, most persons were better able to judge of the qualifications of a civil engineer than they were of the qualifications of a physician. He thought, however, that legislation might be desirable to the extent of stating who were and who were not competent to construct public works and that no one not so declared to be competent should be employed by municipalities to carry out public works. Mr. John F. Wallace considered that the qualities demanded of engineers were so diverse that any attempt to establish by legislation who had them and who did not would be absolutely impracticable. Mr. Clemens Herschel agreed with Mr. Wallace. Mr. E. A. Bond doubted the wisdom of legislative restrictions. The unfit engineer might get some work, but he would not get important work. He believed that the business men who directed and prosecuted undertakings requiring engineering skill of high order were not likely to be deceived to any great extent by the shyster engineer. Mr. Desmond FitzGerald moved that a committee of five be appointed to report at the next annual convention upon the subject under discussion.

The second subject was Concrete-Steel Construction, and the discussion on it was opened by Mr. R. S. Buck. Mr. Buck called attention to the increasing use of steel-concrete construction, particularly for arch bridges, and spoke of the general lack of definite knowledge regarding many points upon which it was desirable for the engineer to be informed if he were to design properly such bridges. Prof. H. S. Jacoby, Mr. A. L. Johnson and others presented written discussions of a mathematical character.

THIRD SESSION.—At the third session of the convention the subject of water-waste prevention, which there

the center sills. It is realized that it is not always possible to place the draft rigging on the neutral axis of the center sills with this construction, but this does not affect the correctness of the principle.

Where the lowering of the car floor is objectionable, the committee recommends that the draft timbers extend at least to the body bolster. There are, however, preferences for continuous draft timbers, and a design in metal is shown in Fig. 25, consisting of two unbroken steel channels running from end to end of the car in place of the draft timbers. This is a design of the Lake Shore & Michigan Southern Ry. A design of the Baltimore & Ohio with continuous wooden draft timbers is also shown in Fig. 18.

Another construction recently used by the Chicago, Burlington & Quincy, and shown in Fig. 12, puts the line of draft on a level with the bottom of the center sill; this avoids cutting away the end sill about the coupler.

There would seem to be no reason why there should not be uniformity in new car construction regarding the spacing of center sills. The present recommended practice of the Association is an 8-in. sill spacing. This now seems inadequate, and on account of the general use of both twin and tandem spring arrangements, it seems desirable to modify this and settle on two dimensions of sill spacing. The committee suggests 10 and 14 ins. These dimensions are recommended because one or the other will take, conveniently, any of the draft riggings now being used, and will enable two lengths of follower plates to be used instead of a variety of lengths. The 10-in. center sill spacing is ample for underhung rigging of both the twin and tandem types, and the 14-in spacing will take any rigging attached between the center sills. In metal construction, this wider spacing is also required to enable the rivets at the bolsters to be machine driven. It is recommended that 10 ins. and 14 ins. be adopted as standard distances between center sills.

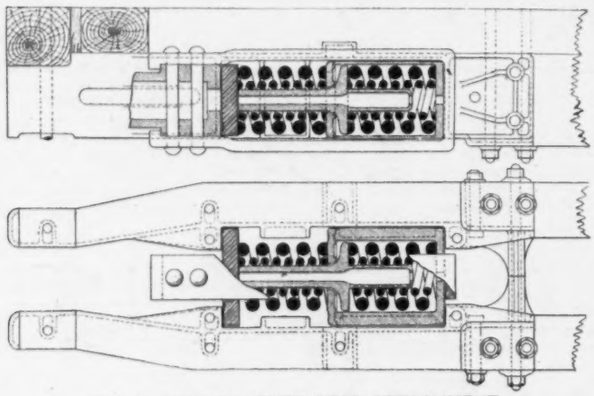


FIG. 8. BUTLER DRAFT GEAR ATTACHMENT.

DESIGNS OF DRAFT GEAR.—As showing recent practice in draft gear, drawings are presented, Figs. 1 to 25, of various gears which are now on the market, or are being applied by railroads in accordance with their own designs. It will be seen that with one exception these gears are designed to pull the car from the head end, which seems to be the type of draft gear that is generally preferred, although the gear referred to as an exception is used extensively.

While there are two ways of receiving the pulling forces on the car, through attachments at the front end or through attachments at the rear, the principle of all draft gear as refards buffing forces is alike, i. e., the buffing strains are taken by the draft gear proper until the spring or other resistance is exhausted, when the remainder of the shock is transmitted direct to the car framing through the coupler horn or buffer blocks, if present. In the latest draft rigging, the friction gears, the capacity of the gears to absorb shocks has been increased to between 100,000 and 160,000 lbs., leaving a smaller proportion of shock to be transmitted at the coupler horn, this increased capacity being obtained with practically no recoil. It is readily conceded that the theory of the friction draft gear is correct, but few have had any experience with these gears; they have not been in service long enough to estimate their life or wearing qualities, or in any way determine whether the increased first cost and greater complication is warranted. At the present time the committee has no recommendations to make as between friction and spring gears.

Last year the draft-gear committee disagreed as between the tandem and twin-spring arrangements. The present committee considers that the arrangement of the springs is largely a matter of preference. Both have advantages and disadvantages. As the tandem arrangement is usually applied, the breaking of one spring does not cripple the rigging as with the twin arrangement; shorter followers can be used with the tandem; the pull is more central and it is easier fitted to old cars with the sills close together. The twin arrangement, on the other hand, permits of a shorter and lighter yoke. In some cases the long leverage of tandem yokes causes trouble by shearing off the rivets which join the yoke to the coupler. The rear spring of the tandem arrangement extends back so far from the end of the car that it cannot be inspected without going under the car, and it is doubtful if the rear spring and follower ever gets much attention from the inspectors. None of these objections are very serious, and the committee in its future recommendations will provide for the use of both twin and tandem-spring arrangements. The committee is of the opinion that draft gear of the same capacity should be used on small cars as is used on cars of the largest capacity.

WOODEN DRAFT TIMBERS AND METAL BEAMS.—Metal draft beams are being used extensively in place of wood timbers where the rigging is placed below the sills. These are of a variety of designs; they are of various lengths and are commonly made in each case to suit the car framing. The committee has considered the advisability of recommending a standard spacing of bolts and lugs, with a view to having different draft riggings as a whole interchangeable one with another. It is free to say the adoption of such a standard has met with little favor, and is considered rather impractical even by members of the committee. The point is made, and it seems reasonable, that these metal beams will probably last the life of the car and will require renewal only in case the cars are broken in wrecks. If the metal beams do not do that, they will fail to meet the expectations of designers. With this in view, it seems hardly worth while to attempt to standardize this detail, as a good deal must be sacrificed for the sake of uniformity. Any such general scheme for a standard spacing of bolts and lugs would, first of all, mean the doing away of the shoulder at the sill or dead block, as it will readily be seen that the location of this shoulder from the end of the beam is governed by the car framing; that is, by the sizes of timbers used and also by whether a dead wood is used outside the end sill. The lug or lugs would then be the only projections above the upper face of the metal beam, and these could easily be located a fixed distance from the end of the beam. In the same way the vertical bolts holding the beams up to the sills would all have to be in line and a fixed distance from the inner face of the center sill, and the bolt spacing would need be a rather arbitrary one. To insure that one draft rigging as a whole would interchange with another, the distance from the bottom of the sills to the line of draft would have to be fixed. It would not be hoped to make so good a construction in this way as by designing the metal beams with ample shoulders to suit the car framing. The committee merely presents thais idea to the convention for discussion, as some have expressed themselves in favor of a standard metal draft beam.

FIG. 15. HINSON DRAFT GEAR ATTACHMENT.

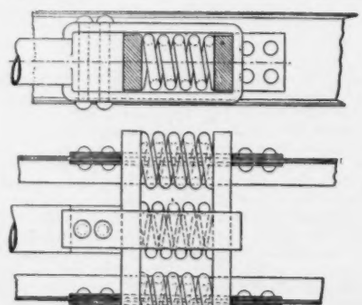


Fig. 22. L. M. Slack Triple-Spring Draft Gear.

No better way is known of attaching wooden draft timbers or metal beams to the sills than by vertical bolts, which should be ⅞-in. or 1 in. in diameter. Wide keys or lugs are preferred to small keys, well removed from the body bolsters, where the sills should be maintained full section.

SPRINGS.—It is found that the M. C. B. draft spring, 6¼ ins. in diameter by 8 ins. high, is used generally in spring riggings; at least the dimensions adhered to and should be retained.

The Cleveland, Cincinnati, Chicago & St. Louis R. R. is using draft springs of larger capacity than the M. C. B. spring, but of the same outside dimensions. These springs have three coils which fit closely, one coil within another. The outer coil tested alone to 6 ins., requires a pressure of 16,700 lbs.; the second coil alone, 5,400 lbs., and the inner coil alone, 1,400 lbs. Compressed separately to 6 ins., the coils thus have in all 23,400 lbs. capacity, but when assembled, a little over 28,000 lbs. is required to compress the group to 6 ins. The difference is accounted for by the friction of one coil on another. This is mentioned here as showing how the capacity of a spring of the standard dimensions can be increased.

CONCLUSION.—The committee does not feel at this time that it is in position to recommend anything in the way of detail designs to take the place of the present recommended practice for coupler attachments, but it hopes to get from the discussion of the topics suggested and from the tests to be made the data needed to make final recommendations. In the meantime a free expression of opinion will serve as a guide to the committee and to those who are working on draft gears.

As said before, the intention is to make draft-gear tests early next summer. The convention is asked for a free discussion of this question of draft-egar tests and the members are urged, in addition, to try on the rear of tenders the new draft gears, which seem to have merit, so that there may by accumulating some data from actual service.

Accompanying this report are illustrations selected by the committee from drawings submitted by the draft-gear makers and railroads. While there are several different applications of some of these draft gears, the illustrations herein shown represent the principal features of each.

An appendix includes reports of tests which have been made by others than the committee during the past year. These reports show in a general way that the gears tested served the purpose for which they were designed, and withstood severe usage with general satisfaction.

DISCUSSION.

Mr. R. P. C. Sanderson (A., T. & S. Fe) thought the committee should design and build a drop-test machine especially for testing draft gears by jerking or tension. The draft gear should be under a steady strain at the time it receives the shock to correspond to service conditions. Even after such drop tests, however, road tests will be necessary to satisfy the managing officers. It should be understood, however, that there is no sense in attempting to make a draft gear stronger than the center sills of the car. There should be a heavy sill or column in the center of the car to take the shocks. Further, a dead block is an absolute necessity with the M. C. B. coupler, and reliance should be placed on this to take the buffing shocks.

Mr. J. J. Hennessey (C., M. & St. P.) believed nothing in car construction was in greater need of attention than the matter of draft gears. He believed the continuous draft-gear principle was the right one to follow and the shock should be received as nearly as possible at the center line of the car sill.

Mr. C. H. Quereau (D. & R. G.) described a form of continuous draft rigging which made each sill of the car floor a draft sill, a central draft rod runs through the car from end to end.

Mr. F. D. Clark referred to the action of the Burlington system some ten years ago in building a lot of cars with the floor so low that the line of draft was brought nearer the center line of the car sills. These cars gave good satisfaction except that it was difficult to inspect the trucks and the wheels.

had not been time to consider the previous day, was discussed at some length. The discussion was of a general nature and brought out few facts not already familiar to those who have followed closely the recent literature upon this question. The necessity of preventing the waste of water was conceded by all of the speakers and practically all agreed that the methods of prevention which suggested themselves as being the most practicable were the use of meters and systematic and rigid inspection with the view of reducing underground leaks.

After a vote of thanks to the Engineers' Society of Western New York and others who had provided accommodations and entertainments, the convention adjourned.

CENTRAL AVE. FREIGHT STATION AT CINCINNATI; C., C., C. & ST. L. RY.

The large new freight station of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Central Ave., Cincinnati, represents some rapid construction work done under emergencies. The original station, built in 1889, was completely destroyed by fire on Saturday morning, Sept. 30, 1900. A temporary house was immediately erected, so that on Monday morning, Oct. 2, freight business could be taken care of at the site. The reconstruction of a new building was at once taken in hand, and on Nov. 30 this new station was completed and ready for business.

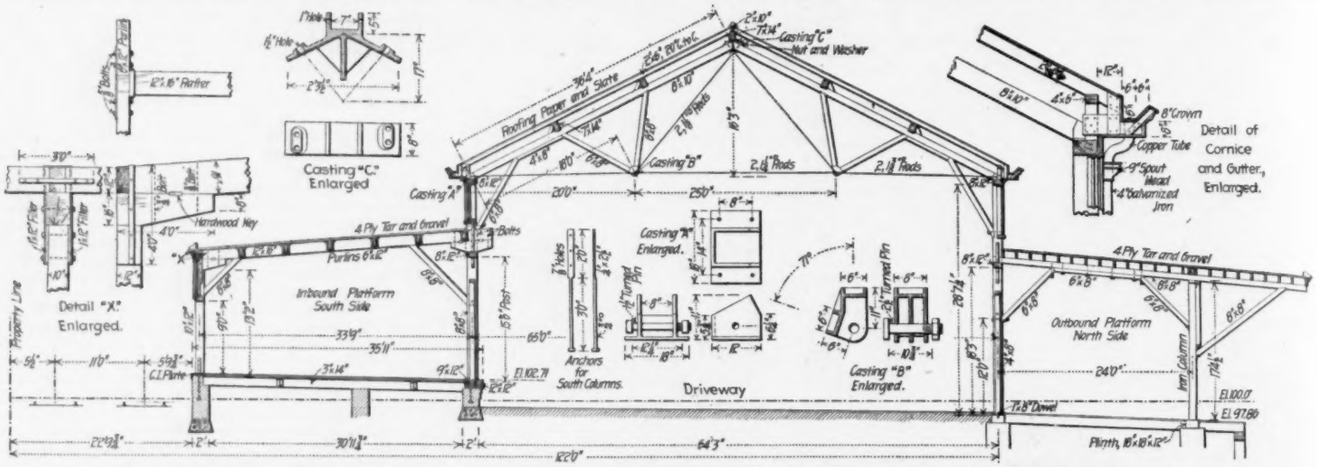
The temporary house was so erected that the permanent building could be erected without in any way interfering with it, except to occasionally cut holes in the roof for the permanent posts. In this way it was possible to do a great deal of work on the permanent house, using the roof of the temporary house as a floor; this greatly facilitated the handling of materials, and (which was most important) avoided interference with the transaction of business below. During the whole time of the erection of the permanent house, business was transacted over the greater portion of the building with comparatively slight interruptions. The work of rebuilding was carried on day and night until the work was completed.

The original station was designed by Mr. Robert L. Read, M. Am. Soc. C. E., who was then Engineer of Terminal Construction, and the reconstruction was carried out under the direction of Mr. George W. Kittredge, M. Am. Soc. C. E., Chief Engineer of the C., C., C. & St. L. Ry. We are indebted to Mr. Kittredge for plans and other information.

The design of the new building is different from that of the old one. The latter included a three-story brick warehouse over nearly half of the structure, which was omitted in rebuilding. The original building was also low-studded and dark, necessitating the use of artificial light much of the time, while in the new building particular attention was given to having every part of it well lighted by day. A cross-section of the new station is given herewith.

The building is 743 ft. long, extending from Central Ave. to Smith St., on the line of South Pearl St., with a lateral entrance on the south from John St. Its total width over the platform foundation walls is 130 ft., or about 137 ft. over the roof. The central bay is 65 ft. wide, c. to c. of columns, and forms the driveway, spanned by combination roof trusses. On the south side is the platform for incoming freight, 33 ft. 9 ins. wide c. to c. of columns, and having a shed roof supported by columns on the edge of the platform. Two tracks, 11 ft. c. to c., are laid alongside this platform, and at the east end of the building these are on a curve of 28°. The center line of the inner track is 5 ft. 9 ins. from the edge of the platform on the tangent, and 6 ft. 6 ins. from it on the curve, while the edge of the platform is 3 ft. 9 ins. above the rail level. There is no outside platform along the front of the house, as in many freight houses, so that freight unloaded must of necessity be at once under cover. This arrangement prevents the trouble experienced from claims for damages to freight unloaded on the outside platform and carelessly left exposed to the weather. No outside platform between tracks on the south side of the building was built, because the width of the property was insufficient to allow of this without sacrificing one of the tracks. The officers of this road, however, are firm believers in island platforms between tracks, and use them wherever practicable.

On the north side of the building is the platform for outgoing freight, this platform being 30 ft. wide, with columns 24 ft. from the main columns. The shed roof extends about 7 ft. beyond the edge of the platform, so as to protect it from the weather, as this side of the building is closed only by gates of open construction.



CROSS-SECTION OF CENTRAL AVE. FREIGHT STATION AT CINCINNATI; CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RY.
Geo. W. Kittredge, M. Am. Soc. C. E., Chief Engineer.

The platforms have timber flooring, the wearing surface being of maple, and are laid with a slight inclination to facilitate the handling of freight. The platform for inbound freight slopes downward from the tracks towards the driveway; and that for the outbound freight slopes from the driveway towards the track. The driveway is of sufficient width to provide ample room for the handling of teams and wagons at each side. It is paved with asphalt, which has proved very durable and satisfactory under the exceptionally severe treatment to which it is subjected. At each end is a portion paved with granite blocks, and all unloading of barrels of oil, etc., is required to be done at these points, as oil on the asphalt would soon cause its destruction. When the building was rebuilt in 1900, brick paving was laid between the main driveway and the edge of the inbound platform for a width of 15 ft. There was so much timber in the old structure that the fire was a particularly hot one, and the officials were interested to see what effect it would have on the asphalt driveways. Much to their surprise, the asphalt was found in condition to be used immediately after the debris was cleared away. The outer coating, for a thickness of about ½-in., was so burned that it had to be scraped off and a new wearing surface of asphalt applied. It is doubted whether any other paving would have given such good results for so small an expenditure of money.

The building is mainly open at the sides, but has brick walls, with foundations resting on a bed of concrete. The south wall rests on pile foundations. The columns supporting the roof are spaced 21 ft. apart, c. to c., lengthwise of the building. The main columns are 12 × 12 ins., 15 ft. 6 ins. high on the inbound side and 18 ft. 3 ins. on the outbound side. These carry wall plates 8 × 12 ins. for the support of the platform roofs, and above these the columns are carried up to support the wall plates of the central roof, the trusses of which are 21 ft. c. to c. The load is not carried entirely on the wall plates, but is transferred by struts and braces to bearing points on the columns. The top chords, forming the rafters, are of timbers 8 × 10 ins., with purlins 7 × 14 ins., and jack rafters 2 × 6 ins., spaced 20 ins. c. to c. Upon these is laid plank sheathing covered with roofing paper and slate. The two tension members of the truss are each composed of two rods 1⅛ ins. square, with the lower ends looped to fit over 2½-in. turned pins, and the upper ends set up by nuts and washers. The bottom chord consists also of pairs of rods, looped at both ends. Those of the middle panel are 1¼ ins. square, looped over the 2½-in. pins. Those of the end panels are 1⅝ ins. square, looped over the 2½-in. pins at the inner ends and over 1½-in. pins in the end bearings.

The roof over the inbound platform has rafters 12 × 16 ins., resting on corbels or bolsters on the main posts, and on posts 10 × 12 ins. along the edge of the platform. Between the rafters are purlins 6 × 12 ins., carried by iron hangers. The roof over the outbound platform has rafters 8 × 8 ins., supported on wall plates in the main columns and on iron columns on the platform, extending beyond these as shown. Both of these side roofs are braced to the columns, and have a sheathing of grooved and tongued planking 2½ ins. thick for the inbound and ⅞-in. on the outbound side; upon this is a four-ply tar and gravel roofing composition.

The sides of the building are closed at night by portcullis or vertically sliding gates fitted between the columns. These gates are of open rail and picket construction, counterbalanced with a single counterweight to each gate, the arrangement being such that there is no binding of the gate, which can be raised by pressure at either corner. At the east end are the freight offices (at the end of the outbound platform) and a storeroom (at the end of the inbound platform). The latter has doorways closed by Wilson's steel rolling doors. On the inbound platform, also, are closets and the stationmaster's office, on either side of the lateral entrance from John St.

A 6-in. water main is laid along the building, with branches and hydrants at intervals. The roof drainage is carried by down-spouts to 8-in. drains, and there is a surface drain along the lower side of the driveway. The building is lighted by electricity, with arc lamps over the driveway and platforms.

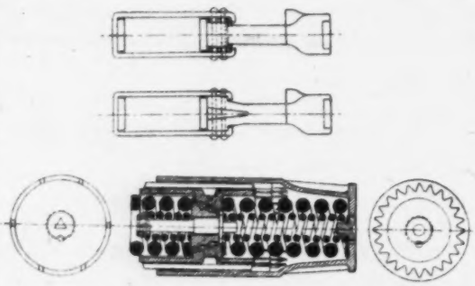


FIG. 1. WESTINGHOUSE FRICTION BUFFER.

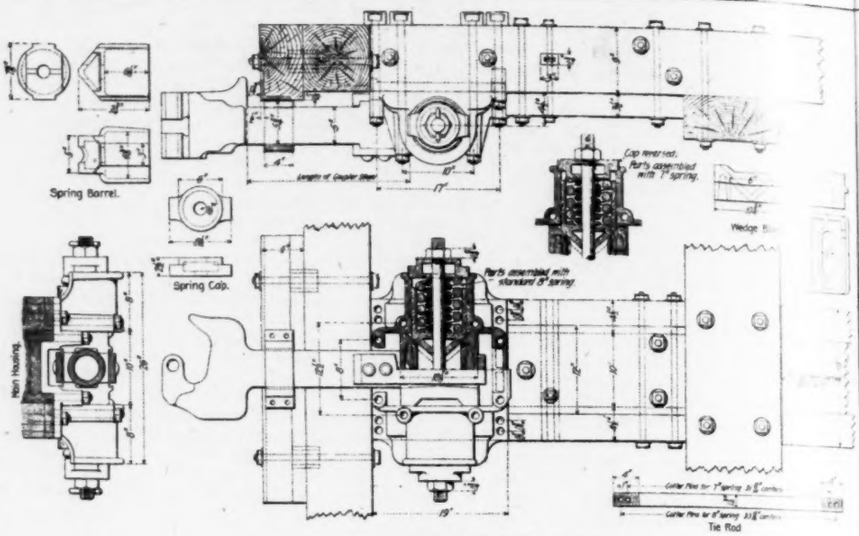


FIG. 4. SESSIONS STANDARD DRAFT GEAR.

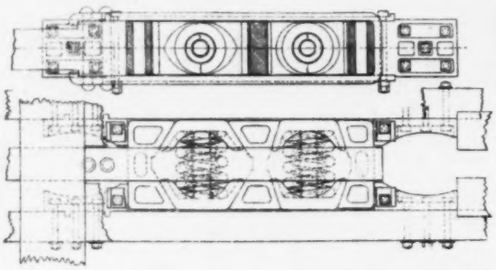


FIG. 5. PIPER DRAFT GEAR AND BUFFER.

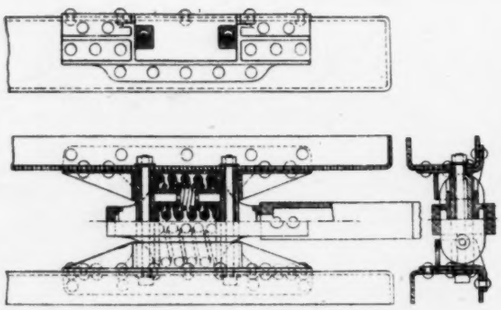


FIG. 11. DAYTON DRAFT GEAR FOR 80,000-LB. PRESSED STEEL CAR.

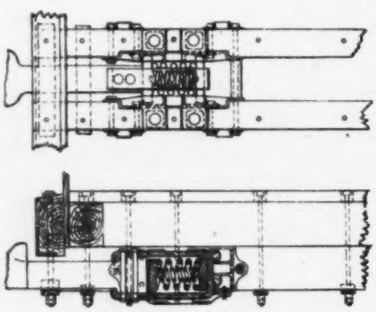


FIG. 10. CONRATH SINGLE SPRING DRAFT GEAR.

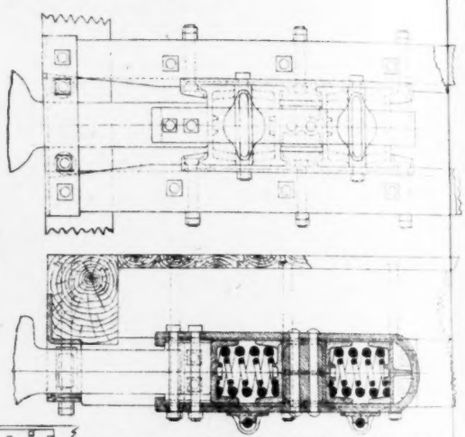


FIG. 24. WILMINGTON MALLEABLE IRON CO. TANDEM DRAFT GEAR.

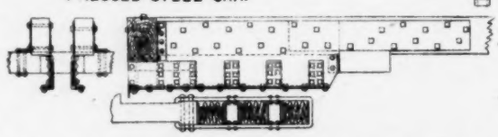


FIG. 13. FRANCIS PLATE METAL DRAFT GEAR.

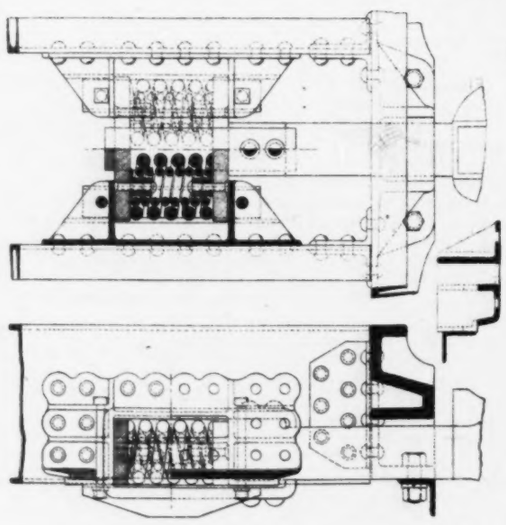


FIG. 7. AMERICAN CAR & FOUNDRY CO. DRAFT GEAR FOR 60,000-LB. TO 100,000-LB. CARS.

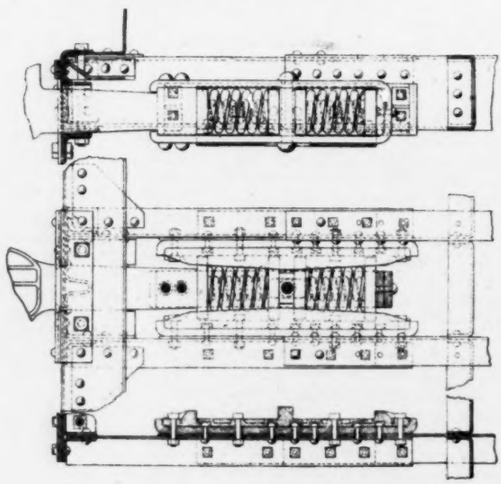


FIG. 18. MINER DRAFT GEAR FOR 100,000-LB. CARS, BALTIMORE & OHIO R. R.

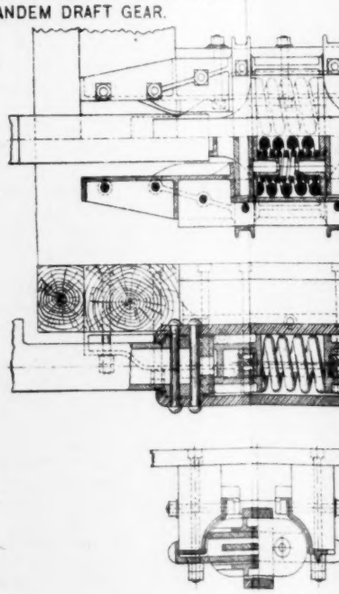


FIG. 12. DAYTON TWIN SPRINGS AND S
C., B & Q. R. R.

MODERN FREIGHT CAR DR

(Reproduced from Plates Accompanying a Committee Report t

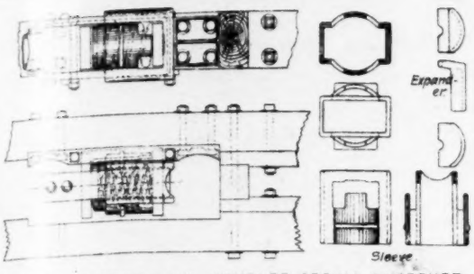


FIG. 6. McCORD & CO. COUPLER SPRING DAMPENER.

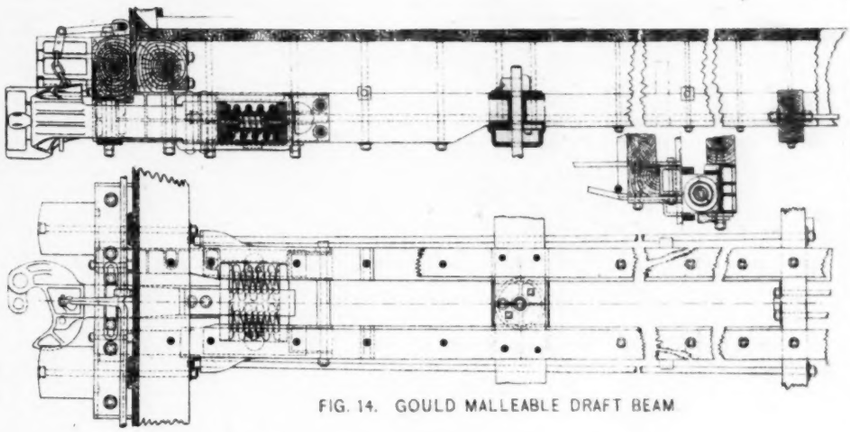
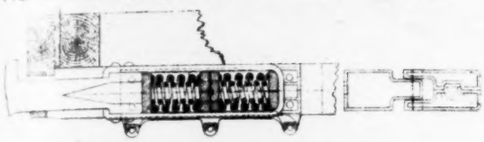


FIG. 14. GOULD MALLEABLE DRAFT BEAM.



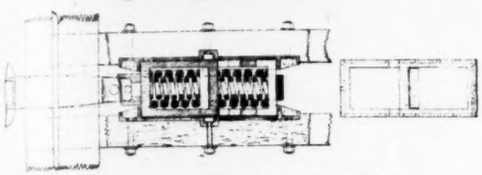
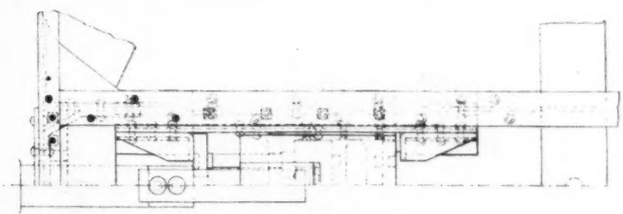


FIG. 23. THORNBURGH DRAFT GEAR.



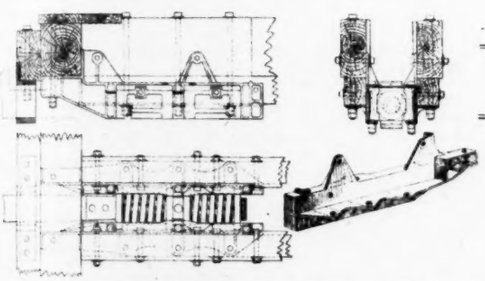


FIG. 17. MINER DRAFT GEAR FOR 80,000-LB. AND 100,000-LB. LOW-DRAFT CARS.

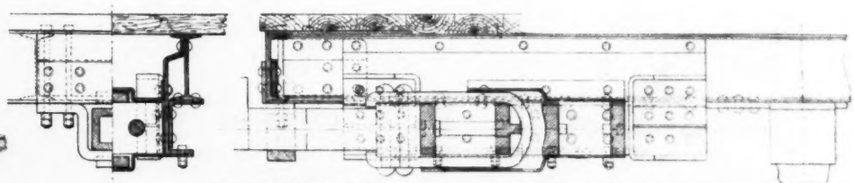


FIG. 9. DRAFT GEAR FOR 100,000-LB. CARS, CHICAGO & ALTON RY.

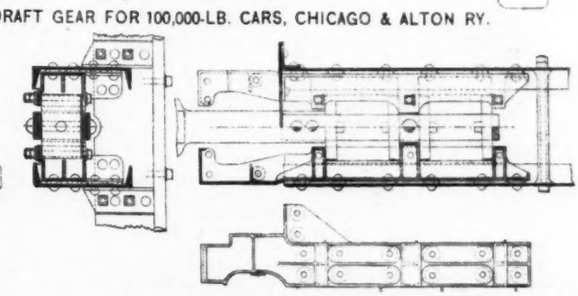
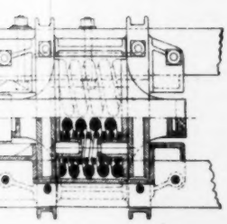


FIG. 20. MINER DRAFT GEAR FOR 80,000-LB. BOX CARS WITH STEEL CENTER SILL, A., T. & S. F. RY.

RON CO.



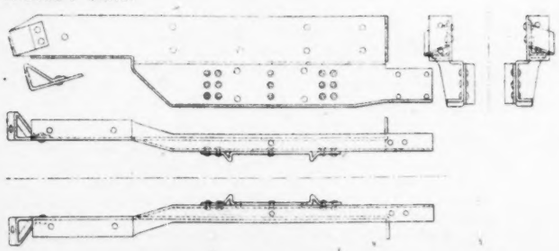
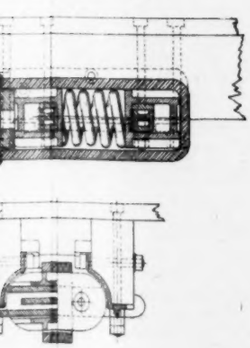
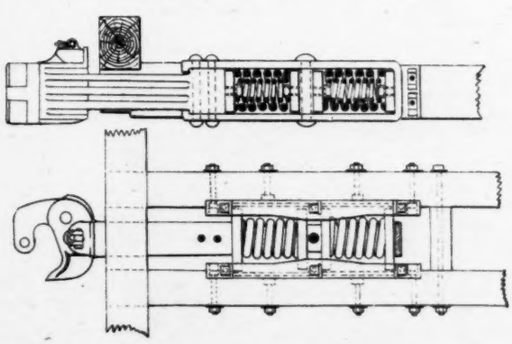
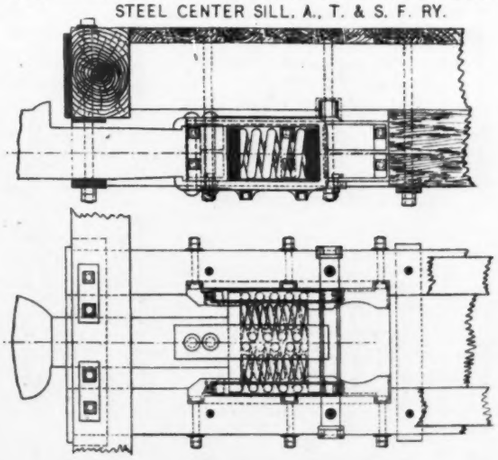


FIG. 16. HEISHLEY'S PRESSED STEEL DRAFT GEAR.







N SPRINGS AND SILL PLATES, B & Q. R. R.

FIG. 19. MINER DRAFT GEAR FOR 60,000-LB. AND 80,000-LB. CARS. WITH WOODEN SILLS.

FIG. 21. MONARCH DRAFT GEAR. CLEVELAND, LORAIN & WHEELING RY.

GHT CAR DRAFT GEARS.

Committee Report to the Master Car Builders' Association.)

CHAS. HART, LITH., 26 VESEY ST., N. Y.